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Quality management laboratory report

Marimekko coffee dye print 2

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1 INTRODUCTION

Over six laboratory sessions, multiple tests were performed on a newly developed coffee-dyed woven fabric from Marimekko. Even though the end use of the fabric was not specified, Marimekko fabrics are generally designed for home textiles. The objective of testing the Marimekko fabric was to evaluate various physical and performance characteristics of the fabric; results being reported to Marimekko.

The laboratory session tests included: abrasion resistance, mass per unit area, colour fastness to rubbing, dimensional change in washing, colour fastness to washing, and pilling and fuzzing resistance. Testing required for the textile was largely determined by the Ecodesign requirements for consumer textiles under sections appropriate to the Marimekko textile. These tests were conducted to evaluate the durability, appearance and behaviour of the fabric for everyday wear conditions.

By testing the Marimekko woven fabric its appropriateness for its intended end use as cushion covers, kitchen textiles, and curtains were assessed. The results in this report help to understand the behaviour of the Marimekko coffee-dyed woven fabric under conditions relevant to its purpose.

2 QUALITY TESTING OF MARIMEKKO COFFEE DYE PRINT 2

2.1 Ecodesign Requirements

According to Ecodesign requirements a textile intended for curtains, kitchenware, and cushion pillows shall undergo colour fastness to washing, abrasion resistance, testing of tear tensile and seam strength, shrinkage in wash/cleaning, and colour fastness to light. These tests ensure the textile meets consumer requirements for long use of textiles in the desired application of said textile. Kitchen towels, napkins, bedsheets, and pillow covers shall achieve a colour fastness to perspiration of 3-4, 4 being the goal. Curtains must have a dimensional stability of ±2%, colour fastness to washing shall be between levels 3-4, and colour fastness to light shall be a level 5. (OVAM 2021, 50-53).

2.2 Abrasion Resistance

Abrasion resistance measures the number of rubs needed to cause a hole in a textile sample. Use of this test is common to determine a fabric's durability in home textiles, workwear, floor coverings, etc.

According to the ISO 12947-2 (2016) standard, three specimens taken from different areas of the fabric should be tested. The diameter of the fabric should be 38mm and taken at least 100mm from the selvedge of the fabric. These specimens are then put into the Martindale machine where the abradant is a wool fabric of a diameter of 140mm. A weight of 9kPa is used to push the fabric onto the abradant. Results can be finalised by the breakage of two yarns with a visible hole for woven fabrics, (ISO 12947-2, 2016.) Abrasion resistance can be calculated using formula 1 where,

$$x_{mean} = \frac{x_{1+}x_2}{2} \quad (1)$$

The average number of rubs is determined from the results of the tested specimen.

2.3 Mass per Unit Area

Mass per unit area measures the mass of a textile material with respect to its area. This measurement helps determine whether the quality of the material is consistent across different areas of the fabric. Testing followed the SFS EN 12127 standard. Samples should first be conditioned before at least 5 specimens are cut out using either a cutting device (100cm^2) or scissors. Specimens shall be cut out to the nearest 1mm. Moreover, specimens shall be cut out at least 130mm away from the selvedge of the sample. Additionally, the mass shall be measured to the nearest 0.1mg. (SFS EN 12127 1997, 4-7).

After measured the specimen's mass per unit area, M, shall be calculated as

$$M = \frac{m \times 10000}{A} \quad (2)$$

Where m is the mass in grams of the specimen and A is the area in square centimetres of the specimen being tested. The result shall then be measured to three significant figures. (SFS-EN 12127 1997, 5).

2.4 Colour Fastness to Rubbing

Colour fastness to rubbing is the ability of a fabric to resist losing or transferring its colour when it is rubbed against another surface. It tells if the fabric's colour would stay fixed on the material when there is friction. There are two main ways it is tested; Dry rubbing and Wet rubbing. Testing followed the standard ISO 105-X12. A standard test would be conducted by rubbing the given fabric with two

pieces of cotton rubbing cloth (50mm squares), one damp and one dry. The results are then assessed by checking how much colour is transferred onto the white cloth using a grey scale. The results are then rated 1 to 5, 5 meaning no staining and 1 referring to heavy staining.

2.5 Colour Fastness to Washing

Colour fastness to washing shows how well a dyed fabric keeps its colour when washed. It measures whether a fabric fades or bleeds on to other fabrics during washing. Testing followed ISO 105-C06 standard. When fabrics are washed, colours can fade or transfer to other materials. This largely happens due to dye molecules coming loose from the fibres, temperature differences, chemicals and mechanical action during washing. In this test, the fabric sample is washed together with a multifibre fabric which was sewn on to the it. The use of steel balls and controlled conditions speeds up the process, so one test can represent one or more real washing cycle/s. After washing, the changes in colour are assessed using a grey scale, which is a standard way to rate colour fastness of a fabric. (ISO 105-C06:2010)

2.6 Dimensional Change in Washing

Dimensional change (also known as dimensional stability) describes a textile's change in dimension after a treatment, such as washing (Golomeova, Jordeva, Zhezhova, Kuzmanoska, Mojsov & Andronikov 2022, 1). The standard ISO 5077:2007 is a method for testing the dimensional change of a textile in washing.

According to ISO 5077:2007, testing should be done after conditioning the sample material. Three specimens should be taken from the sample, but two specimens are acceptable if there is a limited supply of sample material. (SFS-EN ISO 5077:2007 2008, 1.) The specimens should be cut in such a way that they represent the whole sample. The specimens should be cut so that they have different lengthwise and widthwise yarns. The specimens should be 500mm × 500mm in

size, with the edges parallel to the length and width of the sample. (SFS-EN ISO 3759:2011 2011, 2.)

Markings are made on specimens and used for measuring dimensions. The marking should begin by laying the specimens flat on an even surface, ensuring no stretching or wrinkling appears. Then, using indelible ink, a minimum of three markings should be done in both, length and width directions. The markings should be evenly spaced and at least 350mm apart from each other. Markings should also be 50mm or more away from the specimens edges. (SFS-EN ISO 3759:2011 2011, 2-3.) The dimensions of the specimen should be measured before washing (SFS-EN ISO 5077:2007, 2). The measurements should be taken with the specimens lying flat, free of wrinkles and distortion. Additionally, distance between the markings, with the accuracy of 1mm shall be measured. (SFS-EN ISO 3759:2011 2011, 3.)

After marking and measuring, the specimens should be washed and dried, following the specifications described in the standard ISO 6330:2021. After washing and drying, the specimens should be measured again, in the same manner as before the treatment. (SFS-EN ISO 5077:2007, 2.)

Result should be calculated by using the formula 3:

$$\frac{X_T - X_0}{X_0} \times 100 \quad (3)$$

Where X_0 is the dimension before treatment, and X_T is the dimension after treatment, both expressed in centimetres. The result should be expressed in percentages, rounded to the nearest 0,5%. The result should also include a plus sign +, or a minus sign −, to express extension or shrinkage, respectively. (SFS-EN ISO 5077:2007, 2.)

2.7 Pilling and Fuzzing

Pilling is a phenomenon where fibres on the surface of a fabric become entangled, creating pills. Pills are small balls of entangled fibres, which sit on the fibre surface and are generally deemed as undesirable. Pilling typically happens during wear. Different fabrics have different rates of pilling, depending on the qualities of the fibres, yarn, and fabric. Pilling level is typically determined by fibre entanglement, development of additional surface fibre, and fibre and pill wear-off. Development of additional surface fibre causes more fibre entanglement, which leads to pill formation. Fibre and pill wear-off refers to surface fibre and pills to detach from the fabric. (SFS-EN ISO 12945-2:2020 2020, 5-6.)

Fuzzing refers to the visible surface change caused by the fibres on the surface of a fabric teasing or roughing up. The loosened or roughed up fibres on the fabric surface are referred to as fuzz. (SFS-EN ISO 12945-2:2020 2020, 6.)

Generally, pilling and fuzzing are tested simultaneously using the modified Martindale method, following the standard ISO 12945-2:2020. A circular specimen is rubbed against a surface, comprised of the same material as the specimen. The sample should be conditioned prior to specimen cutting and testing. The specimens should be 140mm in diameter. The specimens should be cut at least one-tenth of width of the fabric away from the selvages. The specimens should not contain the same yarns. The number of specimens should be minimum of three sets. Each set consists of two specimens, one to be attached to the specimen holder and one to be used as the abradant. The rubbing should be done at a specified pressure, and an additional loading weight of 260g may be used. The specimens are visually inspected and assessed between each cycle and compared to a reference specimen. (SFS-EN ISO 12945-2:2020 2020, 7-15.)

Visual assessment is done according to the standard ISO 12945-4:2020. ISO 12945-4:2020 states that the visual assessment should be done in a darkened room under an artificial daylight D65 lamp. More than one observer should perform the assessment. The specimen should be placed next to the reference specimen, and the specimens should be held at an angle between 5 and 15 degrees to the light source. The specimens should be placed at a distance from 30cm-

50cm from the eyes of the observer, assuming the observer has normal or corrected vision. The observer assesses the surface change and grades it. Grading should be done based on the visual difference between the tested specimen and the reference specimen. Grading is done according to the grading schemes in ISO 12945-4:2020 (Table 1 and Table 2). The grades may be values between two grades, for example, 3-4 (or 3,5 if expressed as a decimal value). (SFS-EN ISO 12945-4:2020 2020, 6-8.)

TABLE 1. Pilling grading scheme. (SFS-EN ISO 12945-4:2020 2020, 7)

Grade	**Description**
5	No change
4	Partially formed pills
3	Moderate pilling – pills of varying size and density partially covering the specimen surface
2	Distinct pilling – pills of varying size and density covering a large proportion of the specimen surface
1	Severe pilling – pills of varying size and density covering the whole of the specimen surface

TABLE 2. Fuzzing grading scheme. (SFS-EN ISO 12945-4:2020 2020, 8)

Grade	**Description**
5	No change
4	Slight surface fuzzing
3	Moderate surface fuzzing
2	Distinct surface fuzzing
1	Dense surface fuzzing

Each specimen receives a grade after each cycle. The cycles should be as follows: 125 rubs, 500 rubs, 1000 rubs, 2000 rubs, 5000 rubs, and 7000 rubs. A mean value is calculated from the grades of the specimens, and recorded as the grade for that number of rubs. The grade may be rounded to the nearest half grade, if the mean value is not a whole number. The result for the material is the mean of two specimens after the final cycle (7000 rubs). (SFS-EN ISO 12945-4:2020 2020, 8 and SFS-EN ISO 12945-2:2020 2020, 15.)

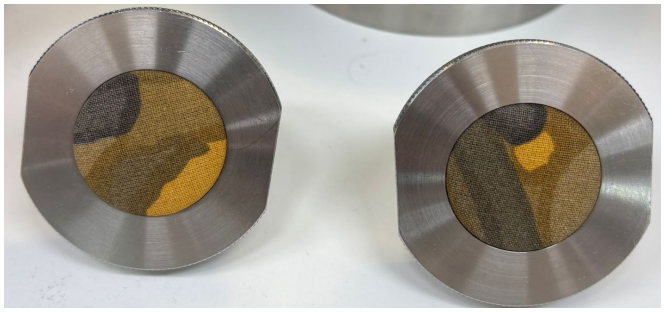
3 METHODS

3.1 Abrasion Resistance

Abrasion resistance testing was done using the Martindale machine (see Picture 1). Two specimens with an area of 38mm were cut using a circular template to draw the outline, then cut out with scissors. The specimens are shown in Picture 2. The testing parameters were as follows: Unit: rubs, Pressure: 9 kPa, Abrasion fabric: 100% cotton, Number of rubs per cycle: 1000. The specimens were attached on specimen holders shown in Picture 2, which were then attached to the Martindale machine, before machine testing begun. Between each cycle, the specimens were taken out and examined for broken threads using a microscope shown in Picture 3. The procedure repeated until 25000 rubs. One of the specimens under the microscope after 5000 rubs are shown in Picture 4. Specimens after 25000 rubs are shown in picture 5. Specimens did not show yarn breakage, but a significant amount of colour loss can be seen after 25000 rubs (see Picture 6).



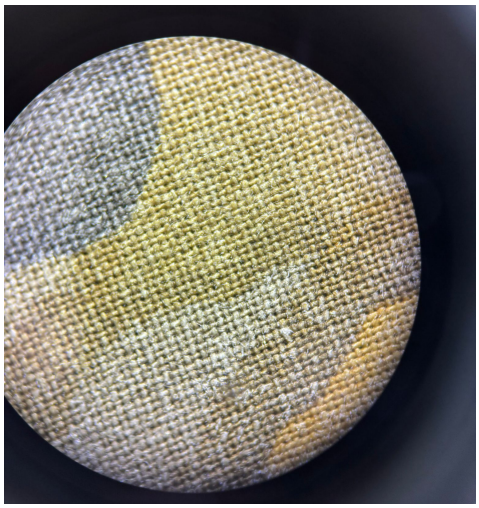
Picture 1. Martindale (Picture: Unna Kenius)



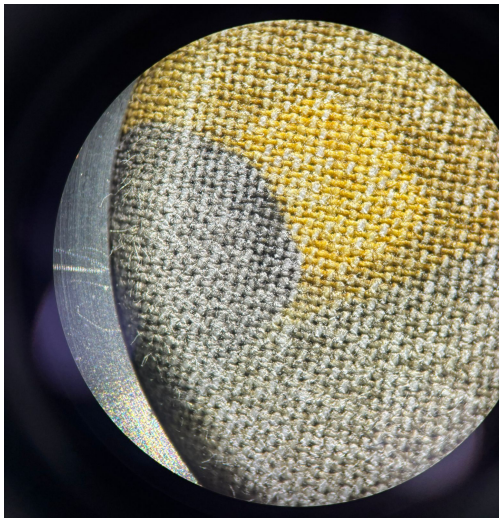
Picture 2. Specimens attached to specimen holders. (Picture: Georgina Delgado Alís)



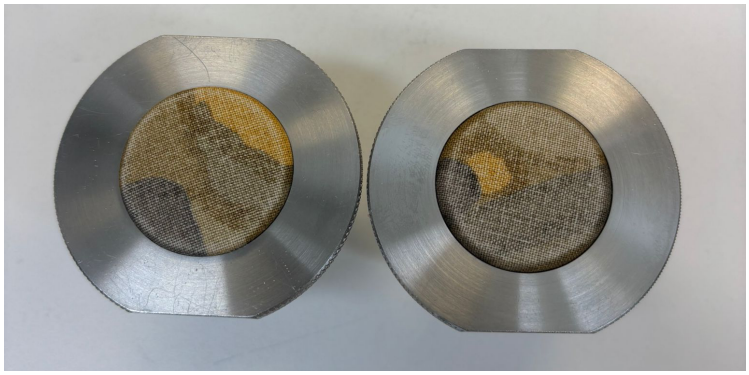
Picture 3. Microscope. (Picture:Georgina Delgado Alís)



Picture 4. Specimen after 5000 rubs. (Picture: Georgina Delgado Alís)



Picture 5. Specimen after 25000 rubs. (Picture: Georgina Delgado Alís)

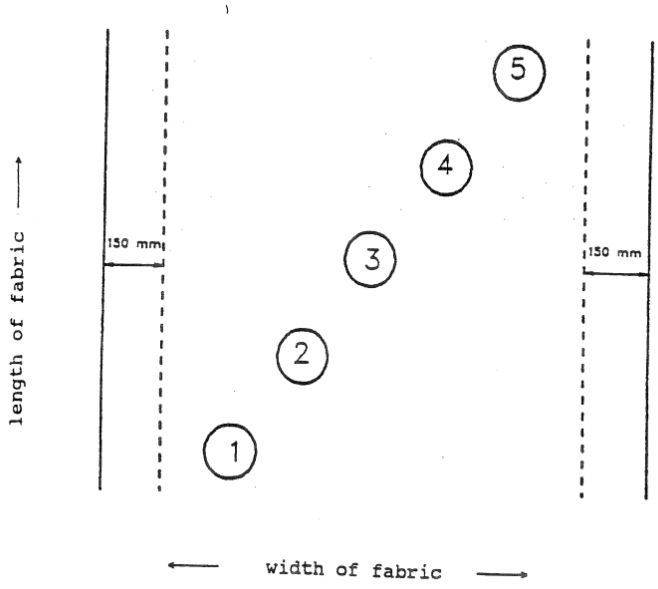


Picture 6. Specimens after 25000 rubs. (Picture: Georgina Delgado Alís)

3.2 Mass per Unit Area

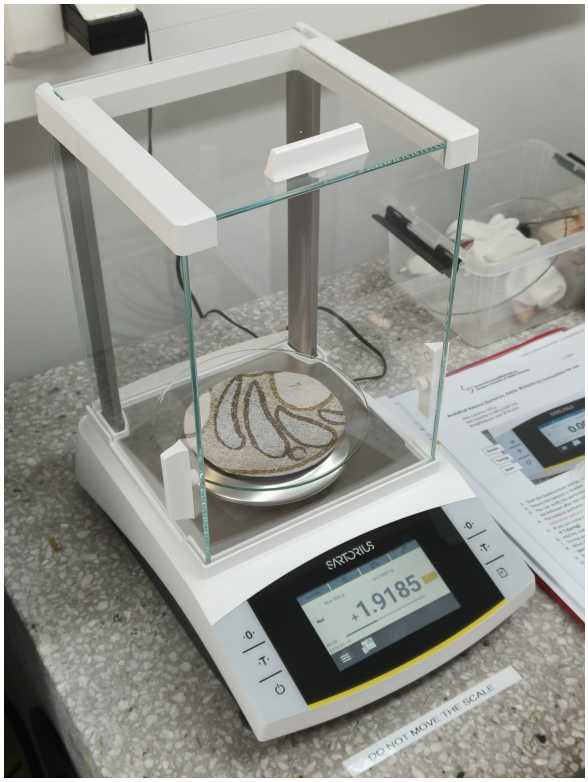
Upon receiving the Marimekko coffee dyed sample, mapping of the specimens according to the standard SFS EN12127 (1997, 7) was followed (see figure 1).

FIGURE 1. Sample mapping. (SFS EN 12127 1997, 7)



Specimens were all taken from different parts of the sample at least 130mm away from the selvedge of the sample. Due to lack of sufficient sample meterage for all tests performed, only three of the required 5, 100cm^2 specimens, were cut from the sample.

After carefully cutting out the specimens to the nearest millimetre, specimens were placed onto a dish in a scale and measured for its weight (see picture 7).

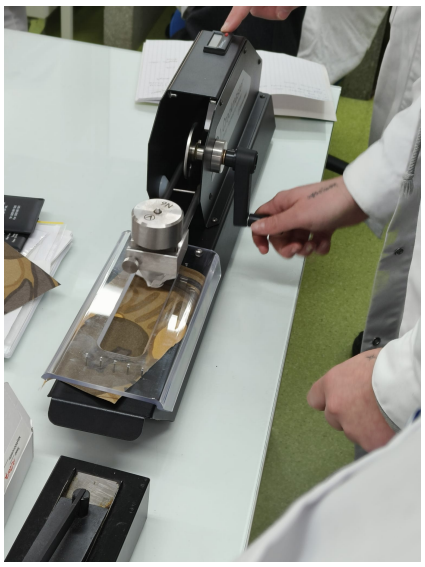


PICTURE 7. Weighing of specimen using the sartorius scale. (Picture: Unna Kenius).

This process was then repeated for the other two specimens. Equation 2 was then used to determine the mass per unit area measurement of each individual specimen before calculating the average mass per unit area of the sample.

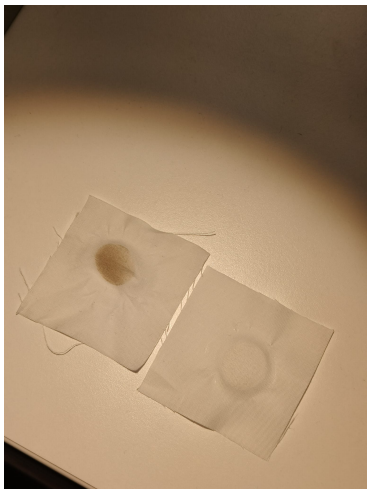
3.3 Colour Fastness to Rubbing

Two specimens were collected from the Marimekko coffee dye fabric. A crock meter was used to conduct the test (see Picture 8), and the samples were placed diagonally on the specimen platform.



PICTURE 8. The sample placed on the specimen platform of the crock meter (Picture: Unna Kenius)

The test was done in two parts, the first part by placing the dry rubbing cloth on the rubbing finger. For the second part, the rubbing cloth was soaked in distilled water, and the excess moisture was absorbed using a paper tissue. It was then placed on the rubbing finger for the wet rubbing test. Each test was completed by turning the handle ten times, resulting in ten rubs. Finally, the rubbing cloths were collected and the damp rubbing cloth was left to air dry before assessing using the grey scale.



PICTURE 9. The rubbing cloth after the test was conducted. (Picture: Unna Kenius)

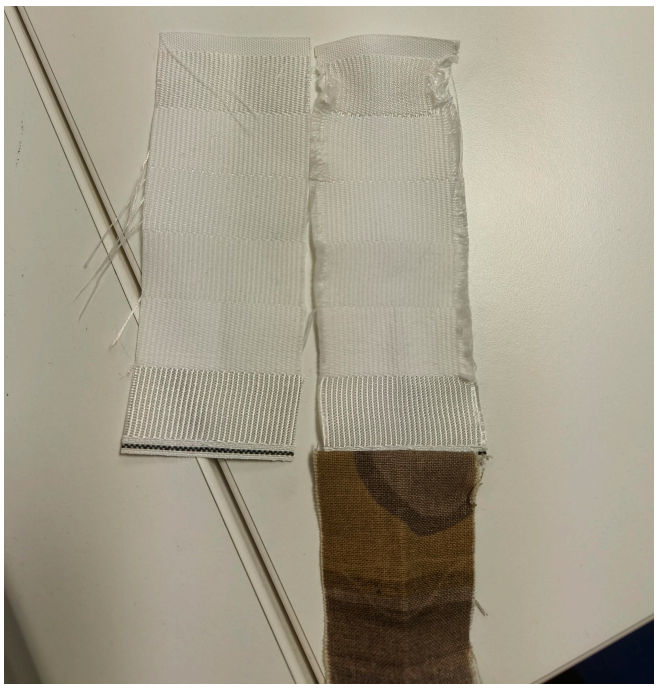
In Picture 9, the rubbing cloth to the left was used in the wet rubbing test and to the right was used in the dry rubbing test.

3.4 Colour Fastness to Washing

According to ISO 105-C06, a sample about 100mm x 40mm was collected for the colour fastness to washing test from the given sample. The collected specimen was attached to a multifibre fabric. The specimens were washed under typical domestic conditions allowing the combined effects of water, temperature and mechanical movement. After the washing cycle, the specimens were rinsed and removed. The fabrics were dried by air drying. After drying, the samples were visually evaluated. The change of colour of the original fabric and any staining on the multifibre fabric were assessed using a grey scale. The multifibre fabric attached to the washed specimen, next to an unwashed multifibre fabric, is shown in Picture 11.



PICTURE 11. Washed specimen (left) next to unwashed material (right). (Picture: Unna Kenius)



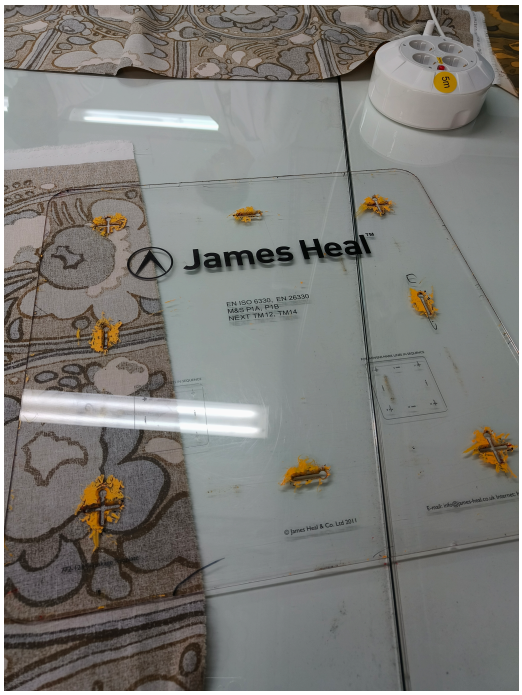
PICTURE 11. Unwashed multifibre fabric (left) next to washed multifibre fabric (right). (Picture: Unna Kenius

3.5 Dimensional Change in Washing

The dimensional change in washing was tested according to the standard ISO 5077:2008. Two rectangular specimens, 50x50cm in size, were cut from different spots of the sample material. Before the specimens were put into the washing machine, they were marked using a stencil shown in Picture 12, and a waterproof marker. The width and length of the specimens were measured using a ruler. Three measurements per direction were taken from both specimens, and the measurement result was the mean value of the three measurements. The measurements were taken from the top edge, middle, and bottom edge of the specimen. In total, six measurements per specimen were taken.

The washing machine used for the test was a standardized washing machine, Electrolux Wascator FOM 71CLS, shown in Picture 13. The specimens were washed at 60°C, the spin speed was 500r/min, and 20g of ECE detergent (non-phosphate, without optical brightener and without enzymes) was used. The specimens were washed alongside other sample materials from other testing groups. The total mass of the specimens from all groups was 620g. The preferred mass of the load in washing is 2kg, so standardised, white, cotton fabric sheets were

added to the washing machine. After washing, the specimens were hung on a line to air-dry. After the specimens were completely dry, they were measured in the same manner as before the washing. The material result was calculated using formula 3.



PICTURE 12. Stencil for marking. (Picture: Unna Kenius)



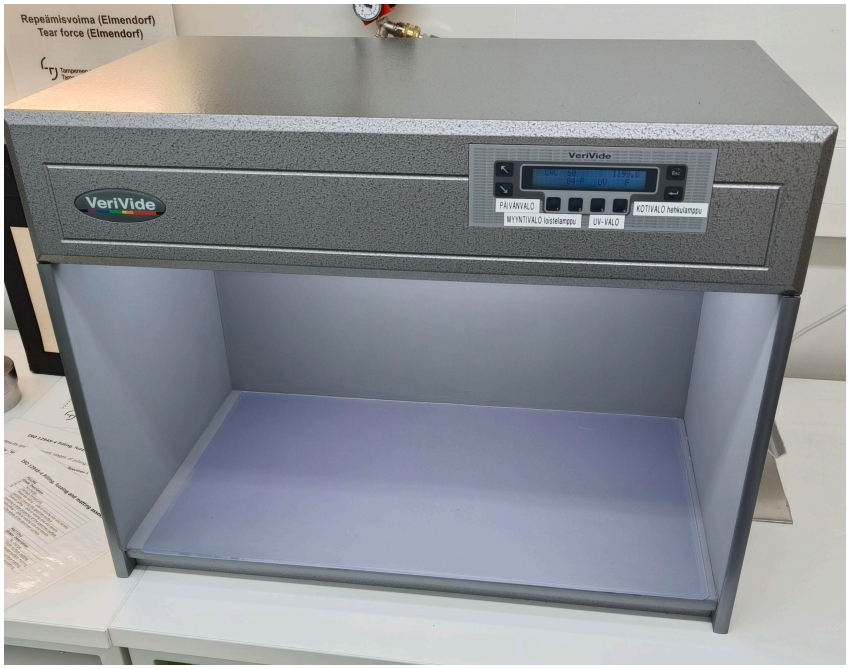
PICTURE 13. Laundry machine. (Picture Unna Kenius)

3.6 Pilling and Fuzzing

The pilling and fuzzing were tested according to the standard SFS-EN ISO 12945-2:2020. The number of specimens was 2, which was less than advised in the standard. The specimens were cut from different spots of the sample material. The test was done using the Martindale apparatus (Picture 1), which rubbed the specimens against the abrasion fabric. The pressure for the test was 415g and the abrasion fabric was the tested material. One of the specimen along with the reference specimen attached to the specimen holders are shown in Picture XXX. The apparatus completed 6 cycles, totalling 7000 rubs. Between each cycle, the specimens were taken out of the apparatus and separately compared to a reference specimen under an artificial daylight lamp shown in Picture XXxX. After each comparison, grades for the pilling and fuzzing were given according to the standard grading from 1 to 5, with 5 meaning no observable change, and 1 meaning significant change. The specimens showed the same amount of change between each cycle, so there was no need to calculate the mean for the grades.



PICTURE 14. Tested specimen (left) and reference specimen (right). (Picture: Unna Kenius)



PICTURE 15. Daylight lamp. (Picture: Unna Kenius)

4 RESULTS

4.1 Abrasion Resistance

Abrasion resistance of the Marimekko woven fabric was tested using the Martindale method under a pressure of 9kPa. Two specimens were tested, the result defined according to the requirements of the standard. According to ISO 12947-2 (2016), the result is reported as the number of rubs before specimen breakdown occurs. All measurement data can be found in Appendix 1. The average was calculated using formula 1:

$$x_{mean} = \frac{25000 + 25000}{2} = 25000\ rubs$$

Since neither specimen showed a breakdown after 25000 rubs, the abrasion resistance can be reported as at least 25000 rubs.

4.2 Mass per Unit Area

Measurements of mass were performed using the sartorius scale. After weighing the mass per unit area was calculated using formula 2:

$$M = \frac{1.9g \times 10000}{100cm^2} = 190\ g/m^2$$

This calculation shows specimen one. Additional individual results can be seen in Appendix 2. An average of 190 grams per square metre was then obtained upon mass per unit area calculation of all individual specimens.

4.3 Colour Fastness to Rubbing

After assessing the rubbing cloth using the grey scale, the dry rubbing test was determined a level 4/5 referring to low staining. The rubbing cloth used in the wet rubbing test exhibited level 1/5 upon the grey scale assessment. This means there was significant staining when the fabric was wet. Individual specimen results can be seen in Appendix 3.

4.4 Colour Fastness to Washing

According to the grey scale ratings, all fibres in the multifibre adjacent fabric achieved a grade 5, indicating no staining occurred during washing. Furthermore, dye did not transfer to other materials. However, the change in colour of the original specimen was graded as 2, which indicates a significant loss of colour or fading after washing. Individual results can be seen in appendix 4.

4.5 Dimensional Change in Washing

The dimensional change in washing of a single specimen was calculated using formula 3:

$$\frac{34{,}1cm - 34{,}8cm}{34{,}8cm} \times 100 = -2\%$$

The results for the sample were the mean results of two specimens. The material result for dimensional change in washing, in the lengthwise direction was -3%. The material result in widthwise direction was -2%. The mean of lengthwise and widthwise direction results is 2,5%. All individual measurement data can be found from the Appendix 5.

4.6 Pilling and Fuzzing

Pilling and fuzzing were graded on a scale from 1 to 5, with grade 5 meaning no observable change, and grade 1 meaning significant change. Material results were the mean of two specimens gradings after the final cycle (7000 rubs). The pilling result for the material was 5. The fuzzing result for the material was 3-4. All individual measurement data can be found in Appendix 6.

5 DISCUSSION

The abrasion resistance test showed that the Marimekko woven material can withstand at least 25000 rubs. Both specimens showed loss of colour and superficial abrasion. However, the woven sample structure remained intact, implying the Marimekko fabric is durable. Due to time constraints, only up to 25000 rubs were tested. To determine the point of yarn breakage further testing is needed.

Ecodesign certification requires that upholstery applicable fabrics be tested for abrasion resistance (OVAM 2021, 53). Criteria classification of flat woven upholstery fabrics followed EN 14465 (2003, 8). Table 3 shows the different Classes for Abrasion Resistance.

TABLE 3. Abrasion resistance classes for cushion covers (EN 14465 2003, 8).

Class A	**Class B**	**Class C**
≥35000 rubs	12000-30000	4000-10000

Based on Table 3, the Marimekko sample is classified as Class B and is appropriate for upholstery applications with medium use (EN 14465:2003, 8). Since the Marimekko sample is made for use as cushion covers this grading is appropriate; cushions experience fewer abrasive stresses than couches for example (Hart Design Selection n.d.)

Mass per unit area was consistent across all specimens tested, resulting in an average mass per unit area of 190g/m^2. Maximum variation level between individual specimens was 1.3 g/m^2. Once rounded according to SFS EN 12127 (1997, 5), the variance was eliminated. Results from Marimekko regarding mass per unit area were also given as a comparison value. According to Marimekko laboratories, the sample had an average mass per unit area of 170g/m^2, meaning results obtained in TAMK laboratories experienced an increase of 11.5% in mass per unit area. TAMK textile laboratory always conditions samples before testing according to ISO 139 (2019). If testing at Marimekko's laboratories was not performed using samples conditioned to parameters set by ISO 139 (2019), this difference in mass per unit area would be explained; when a sample absorbs more

moisture it will become heavier. Additionally, only three out of the five tests required by SFS EN 12127 were observed. This could have affected the results significantly. In future, testing should include all five required specimens.

The results of the colour fastness to rubbing, show significant differences between dry and wet rubbing. In dry rubbing, the sample had a grade of 4/5, which means there was very little colour transfer. However, wet rubbing resulted in 1/5 grade, meaning a lot more staining occurred. This suggests that the dye adheres to the sample when it is dry, but when water is added, the colour does not adhere as well. Coffee dyes are considered a type of tannin dye. Unless the dye molecules were covalently bonded to the cotton sample, these dyes would have sat on the surface of the fabric without penetrating the fibre. Hence, when the Marimekko sample is subject to water and friction the dye molecules likely detach from the cotton fibres attaching onto the water molecules instead (Adeel S., et al. 2020, 2;8).

Ecodesign certification requires upholstery fabrics (cushion covers in this case) and kitchen textiles to be tested for colour fastness to rubbing. Cushion covers fall under EN 14465 for colour fastness to rubbing. Moreover, kitchen textile colour fastness to rubbing requirements follow the ASTM D4111-24 standard (OVAM 2021, 50-53). Table 4 shows the dry and wet grading requirements for the Marimekko sample desired applications.

TABLE 4. Application specific colour fastness to rubbing requirements.

End Application	**Dry Grading**	**Wet Grading**
Cushion covers (EN 14465:2003, 8)	A: ≥4, B: 3-4, C: 3	A: ≥3-4, B: 3, C: 2-3
Kitchen towel (ASTM D4111-24 2019, 2)	Passing: 4	Passing: 3

The dry rubbing grading can pass for a class A grading in cushion covers and passes the requirement for kitchen towels. However, the Marimekko sample does

not achieve the minimum requirements for wet rubbing. Overall, the sample performs well in dry conditions but poorly in wet rubbing, so it may release colour when it gets wet due to water and/or sweat.

Colour fastness to washing shows a clear difference between staining and colour retention. While no staining was observed on any of the adjacent fabrics (all rated 5), the Marimekko sample showed noticeable colour change, resulting in a 2. This indicates that the dye did not transfer to other materials but instead was lost from the sample during washing. The fading can be explained by the effects of temperature, detergent, and mechanical action, which can weaken the bond between the tannin dye and cotton fibres (Adeel S., et al. 2020, 2) (Kingstar Laundry Systems n.d.). Despite the steel balls increasing friction making the washing conditions more intensive, lack of staining suggests that the dye is not easily absorbed by other fabrics. Again, this is likely due to the lack of mordanting that encourages covalent bonding between fibre and dye (Adeel S., et al. 2020, 8). Overall, the sample has limited resistance to colour fading, meaning its appearance changes after repeated washing.

According to Eco design requirements, cushion covers, curtains, and kitchen towels should be assessed for their colour fastness to washing. Ecodesign states cushion covers require the use of EN 14465, curtains ISO 15797 and Kitchen towels ASTM D4111-24 (OVAM 2021, 50-53). Table 5 shows the required classes for the desired applications of the Marimekko sample.

TABLE 5. Application specific colour fastness to washing requirements.

Application	**Required Class/es Colour Change**	**Required Class/es Staining**
Cushion Covers (EN 14465:2003, 9)	A; 4-5, B: 4	A: 4, B: 3-4
Curtains (OVAM 2021, 52)	3-4	Not defined
Kitchen Towels (ASTM D4111-24 2019, 2)	4	3

The Marimekko sample passed staining requirements for each application, however, failed to pass the requirements in all applications for colour change. Hence, the Marimekko sample still needs further development to improve the dye retention of the print.

The dimensional change in washing was -3% in the lengthwise direction, and -2% in the widthwise direction, meaning the specimen shrunk during washing. The specimen was 100% cotton, so shrinkage was expected; cotton is commonly known to shrink during washing. Table 6 can be used to compare the requirements set by different standards and the results from the tested material. According to EN 14465:2003 (2004, 9), the shrinkage for detachable cover fabrics should be ±2% to qualify for class A, or ±3% to qualify for class B.

TABLE 6. Comparative table.

Tested material	**EN 14465:2003 Requirement**	**ASTM D4111-24 Requirement**	**EU Ecolabel Requirement**
-2% & -3% (mean: 2,5%)	A: ±2%, B: ±3%	±5% (after 5 cycles)	±2%

The specimens exhibited different amounts of shrinkage depending on the direction of the fabric. However, both values (-3% lengthwise, -2% widthwise), are within the acceptable range determined by EN 14465:2003 (2004). The material could be considered class B, as the lengthwise change in dimension is too large for class A. According to the standard ASTM D4111-24 (2024), woven fabrics intended for napery and tablecloths should not have dimensional change larger than ±5% after 5 cycles of washing. The result for the tested specimen was obtained from one cycle of washing and therefore, cannot be accurately compared to the requirement in ASTM D4111-24 (2019). According to Ecodesign criteria for consumer textiles (OVAM 2021, 52), the EU Ecolabel provides a requirement for curtain applications: The requirement for dimensional change shall be within ±2%. Since the mean value of change from the two directions was 2,5%. Therefore, according to the EU Ecolabel requirements, the tested fabric would not be accepted for curtain applications.

The specimens also exhibited light coloured lines after washing (Picture 16). The lines were likely caused by the colour fading at wrinkled points during washing. Since cotton tends to wrinkle easily (Liu, Gong, Xu, Ding & Wu 2019), wrinkling likely occurred in the wash.



PICTURE 16. Washed specimens with faded marks. (Picture: Unna Kenius)

These wrinkled parts likely faced more rubbing than the unwrinkled parts. Moreover, the colour fastness to rubbing test showed poor resistance against rubbing in wet conditions. Hence, the wash creases present on the specimens were likely caused by the rubbing friction in wet conditions.

Pilling results achieved a level 5 after 7000 rubs, as there was no visible pilling. The result for fuzzing was 3-4 (3,5). The standard EN 14465:2003 (2004, 8) determines, that the quality level or class of a woven upholstery fabric is A, if the pilling result is 4-5 or above. In the standard, the result is measured after 5000 rubs, however, results of the Marimekko sample obtained in this report were measured after 7000 rubs. Despite the result being recorded after 7000 rubs pilling remained unchanged from 5000-7000 rubs. This means that the tested fabric qualifies for class A, according to the requirements set by EN 14465:2003 (2004, 8).

In future, additional testing should be performed on colour fastness to light, tensile and tear strength to ensure the Marimekko sample adheres to all Eco Design requirements for consumer textiles.

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APPENDICES

Appendix 1. Abrasion resistance

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences

TEST REPORT

Customer	Marimekko
Tester	Unna Kenius, Georgina Delgado Alís, Kaolhinn Jumppanen-Allen, Nawanga Udawaththage
Date	18.02.2026

TEST METHOD	**Abrasion resistance, Martindale** **Determination of specimen breakdown**
Standard	SFS-EN ISO 12947-2:2016
Nominal pressure	9 Pa
Pretreatment	Standard atmosphere (ISO 139: RH65%, T20°C)
Testing conditions	Standard atmosphere (ISO 139: RH65%, T20°C)
Observation method	Microscope (>10 x magnification)
Test interval	1000, 2000, 5000 rubs
Foam backing	Yes

Material details according to the information provided by the customer:

MATERIAL Coffe Dye Print 2, 100% organic cotton, 170g/m2
Colorway 882, plain weave,

Specimens
1. **2.**

Rubs	Observations
1000	No peeling, colour loss
3000	Small peeling can be observed and a noticeable loss of colour
6000	More peeling is shown and some loose fibres
10000	More abrasion and loss of colour is seen
14000	Specimen 2 is starting to get abrasion damage in the edges
16000	We can start appreciating thinner fibres in the edges
20000	Very important color loss is shown as well as yarns getting thinner in the edges
25000	Yarns are worn out and thinner but no breakage is shown

According to standard the results are reported as the number of rubs before the specimen breakdown have been occurred. The final result is the lowest individual result.

Results

Specimen	1.	2.	Result
[Rubs]	≥25000	≥25000	≥25000

End point acc. to standard: two threads broken (woven fabrics)

Appendix 2. Mass per unit area

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences

TEST REPORT

Customer Marimekko
Tester Georgina Delgado Alis, Unna Kenius, Nawanga Udawaththage, and Kaolhinn Jumppanen-Allen
Date 18.02.2026

TEST METHOD **Determination of mass per unit area**

Apparatus Specimen cutter (James Heal)
Scale (Sartorius, Entris)
Standard SFS-EN 12127:1998
Pretreatment Standard atmosphere (ISO 139: RH65%, T20°C)
Testing conditions Standard atmosphere (ISO 139: RH65%, T20°C)

Material details according to the information provided by the customer:

Coffee dye print 2, 100% organic cotton, 170g/m2, colorway 881, plain weave

MATERIAL

Specimen	Weight of 100 cm² [g]	Mass per unit [g/m²]
1.	1,9	190
2.	1,9	190
3.	1,9	190
4.		
5.		
Mean	1,9	190

Appendix 3 Colour fastness to rubbing

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences

TEST REPORT

Customer: Marimekko
Testing laboratory: Tampere University of Applied Sciences/ Textile Laboratory
Date: 09/03/2026

TEST METHOD	**Colour fastness to rubbing, dry and wet rubbing**
Standard	SFS-EN ISO 105-X12:2016
Apparatus	Crockmeter James Heal Crockmaster
Force used	9 N
Crocking finger	16 mm
Soak Percentage	100 %
Pretreatment	Standard atmosphere > 4h (ISO 139: RH65%, T20°C)
Testing conditions	Standard atmosphere (ISO 139: RH65%, T20°C)

Material details according to the information provided by the customer:

MATERIAL Coffee Dye print 2
100% Organic Cotton
170g/m2
Colorway 881, plain weave

Result **Scale 1...5** (Grey scale)

LENGTH	Dry	Wet
diagonal	**4/5**	**1/5**

Appendix 4 Colour fastness to washing

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences

TEST REPORT

Customer: Marimekko
Testing laboratory: Kaolhinn Jumppanen-Allen, Georgina Delgado Alis, Unna Kenius, Nawanga Udawaththage
Date: 09/03/2026

TEST METHOD	**Colour fastness to domestic and commercial laundering**
Standard	SFS-EN ISO 105-C06:2010
Apparatus	James Heal GyroWash
Testing program	C1S
Testing temperature	60°C
Steel balls	Yes
Detergent	ECE Detergent with Phosphates
Adjacent fabric	Multifibre adjacent fabric TV

Material details according to the information provided by the customer:

MATERIAL: Coffee Dye print 2
100% organic cotton
170g/m2
Colorway 881, plain weave

Assesments

Staining	**Grading 1- 5** Grey scale	**Grade**
Multifibre adjacent fabric	Acetate	**5**
	Cotton	**5**
	Polyamide	**5**
	Polyester	**5**
	Acrylic	**5**
	Viscose	**5**
Change in colour	**Grading 1-5** Grey scale	
Change in colour of the specimen		**2**

Appendix 5. Dimensional Change in Washing

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences

TEST REPORT

Customer	Marimekko
Tester	Georgina Delgado Alís, Kaolhinn Jumppanen-Allen, Unna Kenius, Nawanga Udawaththage TAMK Textile laboratory
Date	9th March 2026

TEST METHOD **Determination of dimensional change in washing and drying**

Standard	EN ISO 5077:2008
Apparatus	Electrolux Wascator FOM 71CLS Electolux T5130LAB
Washing program	60°C
Spin speed	500r/min
Detergent	20g, ECE detergent (non-phosphate, without optical brightener and without enzymes)
The method of drying	Line-drying
Number of specimens	2pcs
Pretreatment	Standard atmosphere (ISO 139: RH65%, T20°C)
Testing conditions	Standard atmosphere (ISO 139: RH65%, T20°C)

Material details according to the information provided by the customer:

MATERIAL Coffee dye print 2, 100% Organic cotton, 170g/m2, Colorway 881, Plain weave

LENGTH	Initial length [cm]	Final length [cm]	Result [%]
1. Specimen	34,9cm	33,7cm	-3%
2. Specimen	34,8cm	33,8cm	

WIDTH	Initial length [cm]	Final length [cm]	Result [%]
1. Specimen	34,8cm	34,1cm	-2%
2. Specimen	34,9cm	34,2cm	

State whether dimension has decreased (shrinkage) is marked by a minus sign (-) or increased (extension) is marked by a plus sign (+).

Appendix 6. Pilling and Fuzzing

TEST REPORT

Customer	Marimekko
Tester	Georgina Delgado Alís, Kaolhinn Jumppanen-Allen, Unna Kenius, Nawanga Udawaththage
Date	9th March 2026
TEST METHOD	**Determination of pilling** **Modified Martindale method**
Standard	SFS-EN ISO 12945-2:2020
Loading mass	415 g
Pretreatment	Unwashed Conditioned (ISO 139: RH65%, T20°C)
Testing conditions	Standard atmosphere (ISO 139: RH65%, T20°C)
Abradant	Tested material / standard wool fabric
Number of observers	2 pcs

Material details according to the information provided by the customer:

MATERIAL Coffee dye print 2, 100% Organic cotton, 170g/m2, Colorway 881, Plain weave

Rubs	Pilling mean	Fuzzing mean	Matting mean *)
125	5	5	n.a
500	5	4-5	n.a
1000	5	4	n.a
2000	5	4	n.a
5000	5	4	n.a
7000	5	3-4	n.a

***) only in case of napped fabric.**