GRAIN CHARACTERISTICS COMPARISON OF DIFFERENT TYPES OF SHOE UPPER LEATHERS

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In this study, it was aimed to comparatively investigate the grain properties of shoe upper leathers produced for different purposes. Thus, six different types of shoe upper leather (cracked, antique, patent, nappa, nubuck, printed) were provided from three different footwear companies. The tensile strength and elongation at break (TS EN ISO 3376), single and double edge tear strength (TS EN ISO 3377-1, TS EN ISO 3377-2), cracking and bursting resistance (TS 4137 EN ISO 3378, TS EN ISO 3379), flex resistance (TS EN ISO 5402-1) as well as dry and wet rubbing fastness tests (TS EN ISO 11640) were applied to leathers that have similar thicknesses. The results of the study gave information about the physical strength and product performances of different upper leather types. The data were evaluated comparatively and the effects of shoe upper leather types on quality and performance were evaluated.

Keywords: shoe upper leather, grain properties, quality, strength, footwear

INTRODUCTION

The leather types preferred to use in shoe production vary depending on the type of shoes and climatic conditions of the region. For example, boots manufactured by thicker leathers are generally sold to cold countries such as Russia, Moscow, and Mongolia, while the shoes produced by thin leathers with cloth lining are sold to countries with a temperate climate (Akçakale and Somçağ, 2016).

Footwear producers make their choices by considering some certain physical and chemical characteristics of upper leathers (Hossain *et al*., 2021). In this preference, the priority is the type of shoe, the duration of the footwear and the cost of the upper leathers (Ali *et al*., 2020).

The physical strength of upper leathers also reduces the number of defects in manufacturing that occur during or after the shoe production (Marconi *et al*., 2017). In this context, the physical strength of the upper leathers used in shoe production is of great importance for consumer and producer.

For this reason, in this study, it was aimed to investigate the grain characteristics of six different upper leather types. For this purpose, cracked, antique, patent, nappa, nubuck and printed upper leathers were selected from three different footwear companies and the tensile strength and elongation at break, tear strength, flex resistance, dry and wet rubbing fastness, cracking, and bursting resistance tests were performed to evaluate the results affected the grain characteristics comparatively.

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MATERIALS AND METHODS

Materials

Six different types of shoe upper leathers were obtained from three different companies located in Istanbul and Izmir. Antique, patent, nappa, nubuck, printed and cracked type of leathers were used as the research material.

Methods

The tests were selected considering the physical effects that the shoes are exposed during their usage. Tensile strength and elongation at break, tear strength, flex resistance, dry and wet rubbing fastness, cracking, and bursting resistance tests were carried out in accordance with standards and the classification of upper leathers were given in Table 1.

Table 1. Classification of Shoe Upper Leathers

Type of Upper Leathers	Company A	Company B	Company C
Cracked	1	1	1
Nubuck	2	2	2
Nappa	3	3	3
Antique	4	4	4
Printed	5	5	5
Patent	6	6	6

Upper leathers were kept in standard atmospheric conditions (20°C temperature and 65% relative humidity) for 48 hours according to TS EN ISO 2419 for conditioning prior to physical tests (TS EN ISO 2419).

Tensile Strength and Elongation at Break

The tensile strength and elongation at break test were performed to upper leathers according to TS EN ISO 3376.

Tear Strength

Two tear resistance tests such as single and double edge were carried out by the standards methods of TS EN ISO 3377-1 and TS EN ISO 3377-2.

Flex Resistance

Flex resistance is tested with flexometer device according to TS EN ISO 5402-1. Subsequent to test, the grain characteristics of the samples were evaluated.

Dry and Wet Rubbing Fastness

For dry and wet rubbing fastness test, TSE EN ISO 11640 standard was used, and the leathers and felts were evaluated with a gray scale (TSE EN ISO 11640).

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Cracking and Bursting Resistance Test

Cracking and bursting resistance tests were carried out in accordance with TS 4137 EN ISO 3378 and TS EN ISO 3379.

RESULTS AND DISCUSSION

Fifteen upper leathers differentiated in production type are investigated in terms of grain characteristics. First, the tensile strength and elongation at break results of upper leathers are given in Table 2.

Table 2. Tensile Strength and Elongation at Break Results of Upper Leathers

Type of upper leather	Thickness (mm)	Tensile strength (N/mm^2)	Elongation at break (%)
Cracked-A	1.35	27.50	82.52
Cracked-B	1.59	54.38	51.42
Cracked-C	1.28	10.39	63.48
Nubuck-A	1.67	27.05	50.01
Nubuck-B	2.22	26.46	45.25
Nubuck-C	2.14	20.05	39.75
Nappa-A	1.06	27.05	63.08
Nappa-B	0.97	9.92	67.40
Antique-A	1.53	17.62	43.88
Antique-B	1.11	31.78	49.68
Antique-C	1.75	19.45	44.05
Printed-A	1.08	18.44	49.46
Printed-B	1.08	12.97	49.27
Patent A	1.36	19.91	56.46
Patent -B	1.42	29.19	45.27

The tensile strength value of the shoe upper leathers should have a minimum value of $20N/mm^2$ according to UNIDO standards (UNIDO, 1996). The results are found considerably higher than the tensile strength values specified in the standard in general and required for shoe upper leathers. Printed upper leathers had the minimum tensile strength values while nubuck and cracked leathers had the highest values. The tensile strength of the upper leathers is differentiated depending on the upper leather type. Besides for the same type of leathers like cracked, nappa and antique, the values were differentiated depending on the company where the leathers were obtained.

The double and single edge tearing strength values obtained from the upper leathers are given in Table 3 and 4.

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Table 3. The Double Edge Tear Strength Results of Upper Leathers

Type of upper leather	Thickness (mm)	Double edge tear strength value (N/mm)
Cracked-A	1.15	82.95
Cracked-B	1.61	248.80
Cracked-C	1.27	70.97
Nubuck-A	1.81	144.87
Nubuck-B	2.11	168.44
Nubuck-C	2.01	213.25
Nappa-A	1.03	80.93
Nappa-B	0.79	27.37
Antique-A	0.86	86.81
Antique-B	1.52	151.83
Antique-C	1.63	126.73
Printed-A	1.00	72.58
Printed-B	1.18	50.49
Patent-A	1.26	61.11
Patent-B	1.36	99.13

Table 4. The Single Edge Tear Strength Results of Upper Leathers

Type of upper leather	Thickness (mm)	Single edge tear strength value (N/mm)
Cracked-A	1.29	44.95
Cracked-B	1.73	88.08
Cracked-C	1.31	30.00
Nubuck-A	1.57	60.27
Nubuck-B	2.07	49.35
Nubuck-C	2.08	76.23
Nappa-A	1.11	32.06
Nappa-B	0.82	21.03
Antique-A	1.78	34.97
Antique-B	1.04	43.14
Antique-C	1.69	31.23
Printed-A	1.04	29.18
Printed-B	1.12	28.69
Patent-A	1.33	25.24
Patent-B	1.35	32.68

The single and double edge tear strength values of shoe upper leathers should have been 15N and 30N values respectively (UNIDO, 1996). All results were found considerably higher than the required values and lower tear strength values were found from thinner upper leathers. Minimum results were obtained from nappa upper leather with a value of 27.37 N/mm and 21.03 N/mm for the double and single edge tear strength respectively. The highest double and single edge tear strength values were determined from cracked type upper leather with 248.80 N/mm and 88.08 N/mm respectively.

The results of cracking and bursting strength tests are given in Table 5.

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Table 5. The Cracking and Bursting Strength Results of Upper Leathers

	Cracking		Bursting	
Type of upper leather	Average (kg)	Average (mm)	Average (kg)	Average (mm)
Cracked-A	42.00	1262.33	0	0
Cracked-B	69.33	1204.67	0	0
Cracked-C	46.00	1093.67	28.67	1622.67
Nubuck-A	50.67	1286.67	64.67	1437.67
Nubuck-B	23.67	915.00	43.67	1168.33
Nubuck-C	56.67	1123.33	76.00	1337.67
Nappa-A	10.67	718.33	42.00	1263.00
Nappa-B	9.33	932.00	13.33	1128.00
Antique-A	23.00	1036.00	34.33	1260.00
Antique-B	22.33	848.67	28.33	1050.00
Antique-C	22.33	848.66	28.33	1050.00
Printed-A	15.00	844.67	6.67	987.00
Printed-B	12.33	859.33	4.33	1048.67
Patent-A	17.00	829.33	34.00	1160.33
Patent-B	28.00	861.33	49.00	1123.33

Since the force exceeded 90 Kg during the burst test of leathers belonging to some companies, only the cracking test was applied to those leathers.

The cracking strengths of patent, nappa and printed leathers were found lower than nubuck, cracked and antique upper leathers. It is thought that this is due to the thinness of nappa leather as well as the finishing characteristics of patent and printed leathers. The cracking test is especially important for the areas where the foot bends during the movement of the foot.

Higher fastness values were obtained from dry rubbing fastness. Printed, nappa and antique upper leathers has better dry fastness values in comparison to other upper leathers. The wet rubbing fastness values of antique, cracked, and printed leathers were found higher compared to others. Although good results were obtained in wet rubbing evaluations of nubuck and nappa leather types, it was observed that the felt values were found poor (Table 6).

Table 6. The Wet and Dry Rubbing Fastness Values of Upper Leathers

	Wet Rubbing		Dry Rubbing	
Type of upper leather	Leather	Felt	Leather	Felt
Cracked-A	4	4	4	5
Cracked-B	5	3	5	4
Cracked-C	3	2	4	3
Nubuck-A	3	1	4	1
Nubuck-B	5	1	5	5
Nubuck-C	3	2	4	3
Nappa-A	3	2	5	4
Nappa-B	3	5	4	5
Antique-A	4	3	4	4
Antique-B	3	3	5	5
Antique-C	5	5	4	4
Printed-A	4	2	5	4
Printed-B	5	4	5	5
Patent -A	2	4	4	5
Patent -B	3	5	3	5

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100.000 steps were applied to upper leathers during the flex resistance test. As a result of the test, although wrinkles occurred on the grain side of cracked, nappa, antique, printed and patent leathers, there were no wrinkles on the grain side of the nubuck leathers. In order to prevent or completely eliminate the explosions seen on leather types except nubuck, leathers should be supported with reinforcement cloths produced with natural materials.

CONCLUSION

The grain characteristics of six different type of upper leathers such as cracked, antique, patent, nappa, nubuck and printed were aimed to investigate in terms of tensile strength and elongation at break, tear strength, flex resistance, dry and wet rubbing fastness, cracking, and bursting resistance tests and following conclusions have been drawn:

a. The thickness and the type of leathers directly affect the grain characteristics of the upper leathers; b. The results of the physical tests were found higher than the required values in general.

The physical characteristics of leathers have a direct influence on the performance of the shoes. Therefore, footwear companies should select the upper leathers depending on these characterizations. Besides, cutting, sewing and assembly operators should be informed and trained so they can reduce the number of defective shoes. Additionally, during shoe production, placing a product introductory form describing the leather properties behind the planning forms will enable the operators to have information about upper leathers.

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