## Private Technical Standards used in paint and varnish industries

**Appearance of the liquid varnish**
The purpose of this examination is to assess the quality of liquid varnish by observing its visible characteristics, including color, structure, and the presence of foreign materials. The process involves three stages of evaluation: the first day of production, day 10, and day 30. Throughout the examination, a comparison is continuously made, with the most desirable outcome being a consistent result over the entire 30-day period.

**Appearance of the applied film**
The varnish is applied to 0.213 mm thick A4 aluminum foils for beverage cans, the same material as used in the production line. A cylindrical extender with a thickness of 30 micrometers is used to apply the film, resulting in a layer of approximately 2.3 MSI (mil-square inch). After application, the film is dried in an oven at 200 °C for 4 minutes to solidify the film through solvent evaporation. To ensure quality, the film is analyzed for abnormalities such as color, spreading, cratering, lumps, and orange peeling, compared to a standard through direct observation of the sample's appearance.

**Appearance of the applied film after accelerated stability testing**
Similar to the previous test, however, the dried film is left in an oven at 60 ±5 ºC for 16 h, after which the appearance is checked against the standard.

**Tack determination: to assess drying level**
This procedure is used to ascertain the degree to which paints and varnishes have dried. The drying level can differ depending on the quantity of resin and crosslinking agent employed. To conduct this examination, the varnish is spread onto aluminum sheets, completely cured, and then removed from the oven. After cooling for five minutes, the sheet is touched with the side of the hand to determine if it is sticky. The outcome is recorded as either good or sticky.

**Mobility Test – ALTEK:** determines the coefficient of friction of coated surfaces
The mobility test measures the mobility of enamels and varnishes by determining the coefficient of friction of coated surfaces. To do so, an ALTEK mobility/lubricity tester is used. The test requires cutting sheets to the size of the device, fixing them, and initiating the test. The device pulls a standard rounded weight over the sample, and the result is a numerical value indicating the force needed to move the weight. A lower coefficient of friction yields a better outcome. This test mirrors the sliding of cans during filling. As cans move through the filling line, they require smooth sliding without stopping on conveyors, with approximately 2000 cans per minute on long conveyors. Additionally, sliding is critical for forming specific stages of the can.

**Methyl Violet Resistance:** determines varnish/paint curing degree via methyl violet absorption
The Methyl Violet Resistance Test is a method used to determine the level of curing of varnish or paint by measuring the absorption of methyl violet. In preparation for this test, a 10% solution of methyl violet in butyl glycol is used. To perform the test, a cotton swab is dipped into the solution and then applied to the surface of the varnish or paint. After one minute, the level of absorption is observed. If there is a high level of absorption and the area appears more violet, it indicates that the varnish or paint has a lower chemical resistance. The result is expressed by the coloration of the varnish or paint, with darker areas indicating greater porosity. The ideal outcome is when there is no absorption of methyl violet. If the varnish or paint exhibits a different coloration, this is an indication that the film is not entirely cured.

**Pasteurization with beer, pasteurization with detergent, and pasteurization with water.**
In the beverage can industry, pasteurization is a crucial step that cannot be skipped. It involves using various simulants to test for the efficacy of pasteurization methods like beer, detergent, and

water. To conduct these tests, a varnish-coated aluminum sheet is required, which is then immersed in each simulant. For heating, a water bath is used. The purpose of each solution is unique: beer is pasteurized at 60°C for 30 minutes to eliminate any microbiological activity, water is heated to 80°C for 30 minutes to simulate the pasteurization process for beverages, and detergent (1% water solution) is heated to 80°C for 30 minutes to simulate the can washing process after filling. A satisfactory test is one in which the varnish appearance and adhesion remain unaffected.

## Graphical results of the tests performed on all investigated varnishes

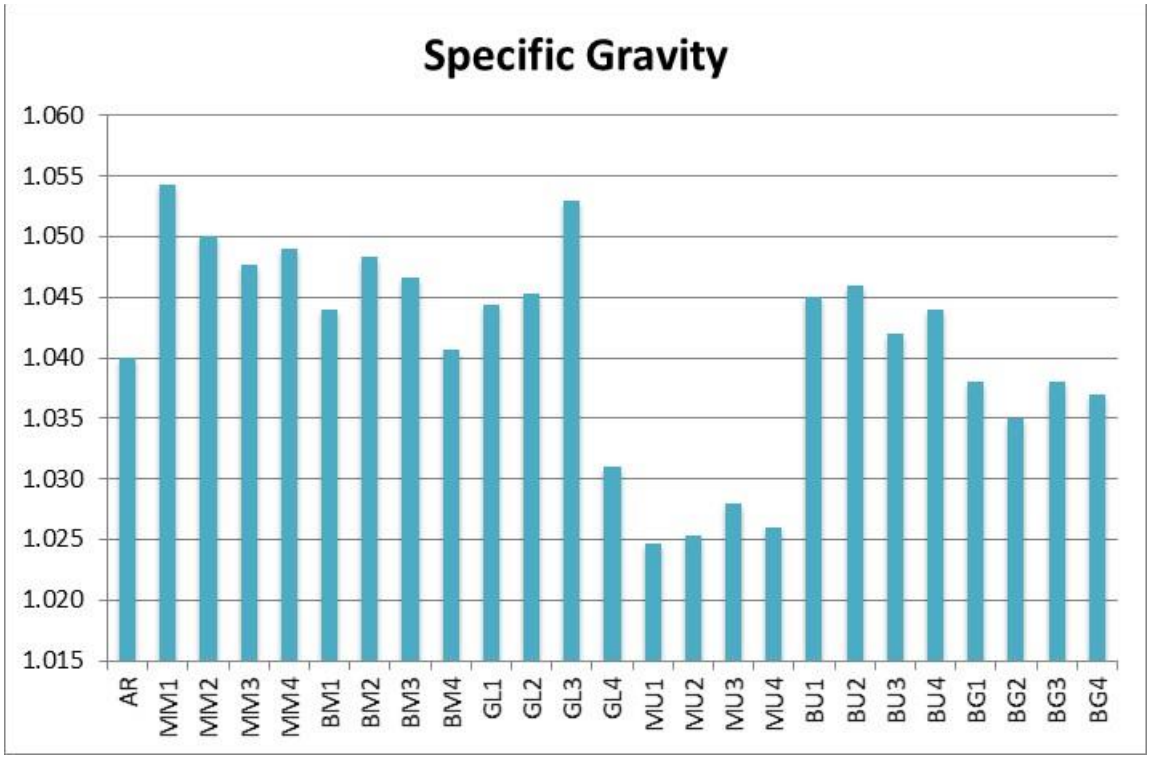



**Figure S1.** Results of the determination of specific mass (ASTM D1475) for all varnishes

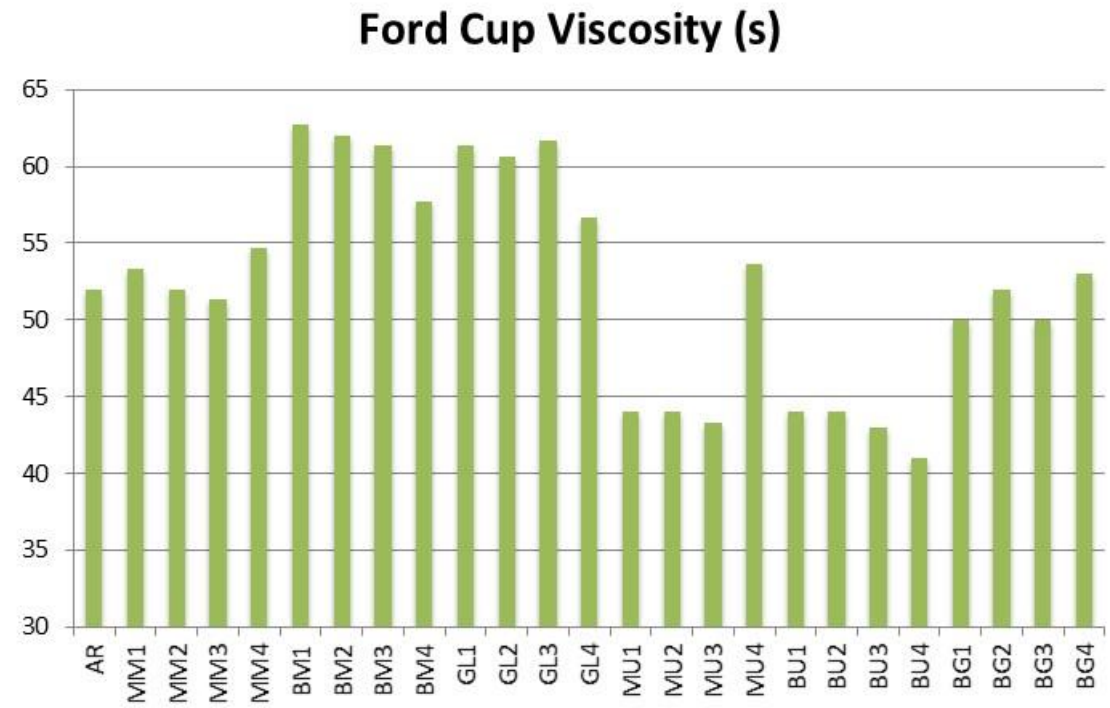



**Figure S2.** Results of the determination of viscosity by Ford Viscosity Cup (25 ± 1 °C) (ASTM D1200) for all varnishes

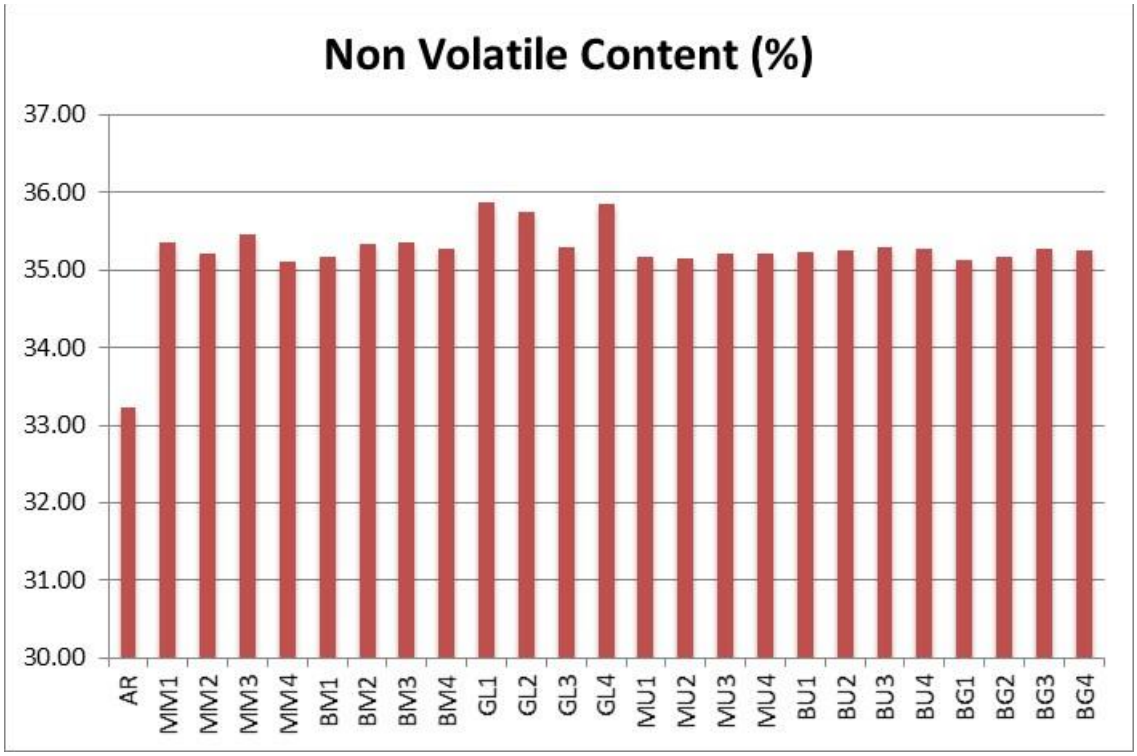



**Figure S3.** Results of the determination of nonvolatile content – 2 h at 135 ± 3 °C (ASTM D2832) for all varnishes

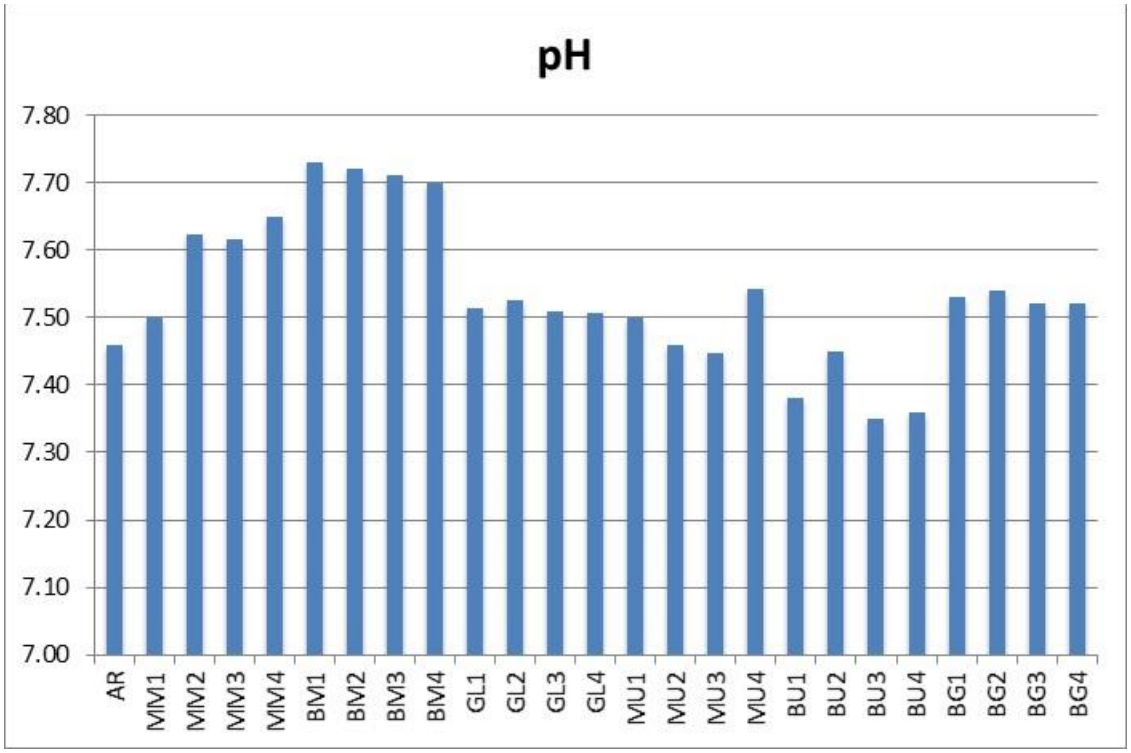



**Figure S4.** Results of pH determination (ASTM D4584) for all varnishes

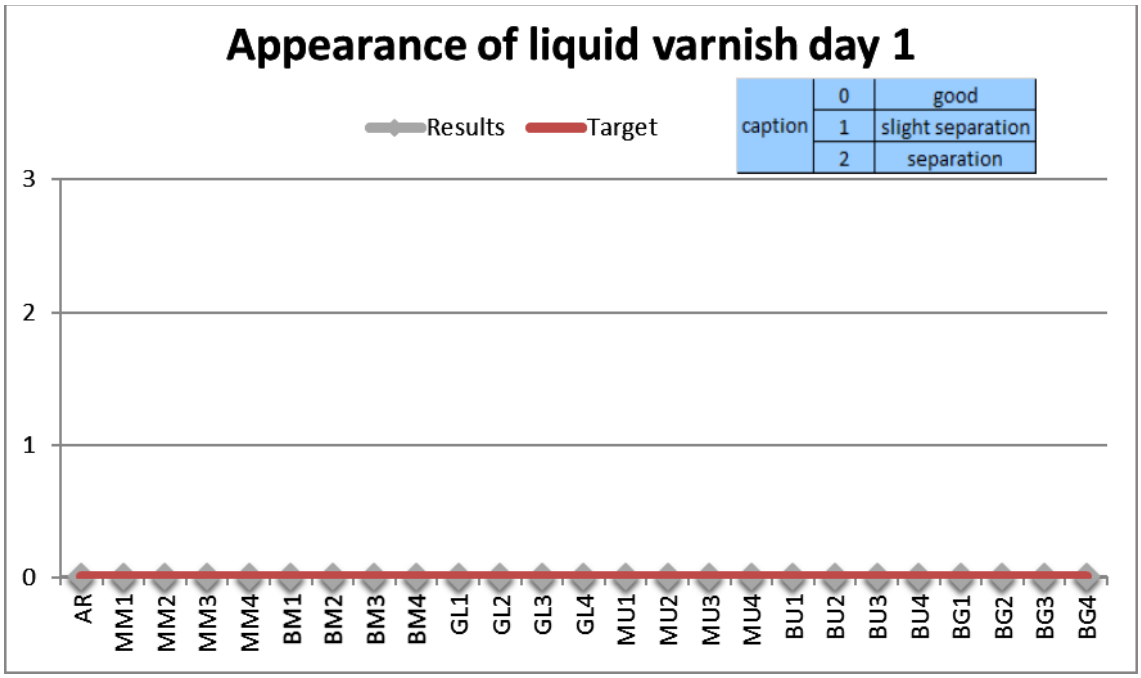



**Figure S5.** Results of the appearance for all liquid varnishes at day of production

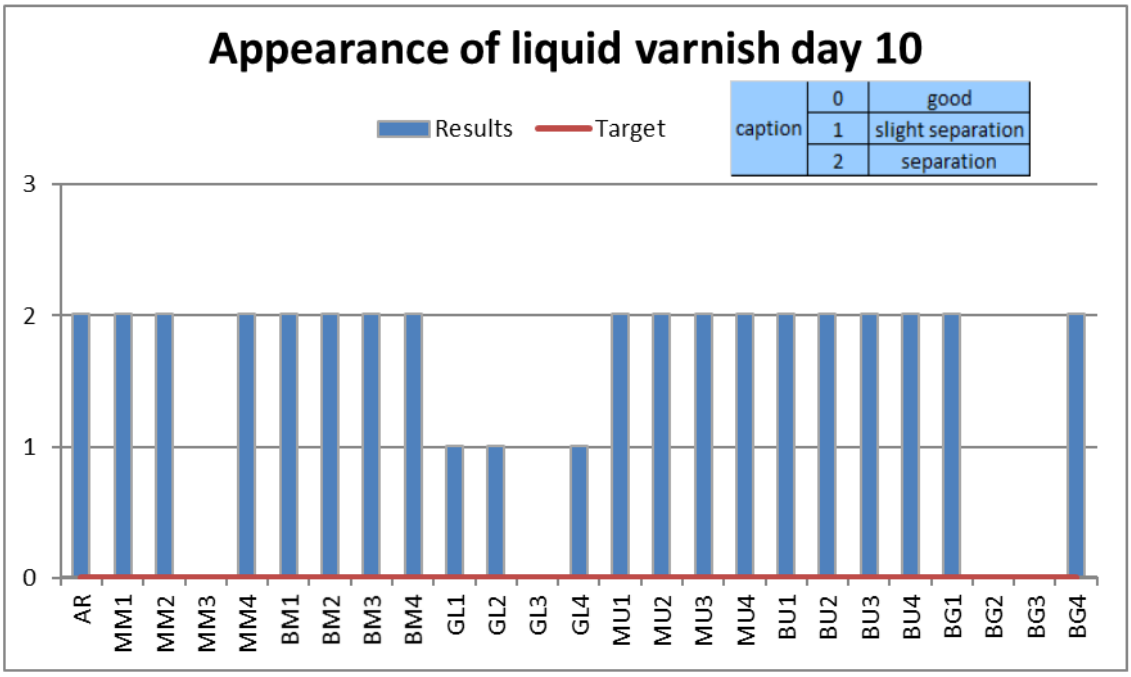



**Figure S6.** Results of the appearance for all liquid varnishes 10 days after production

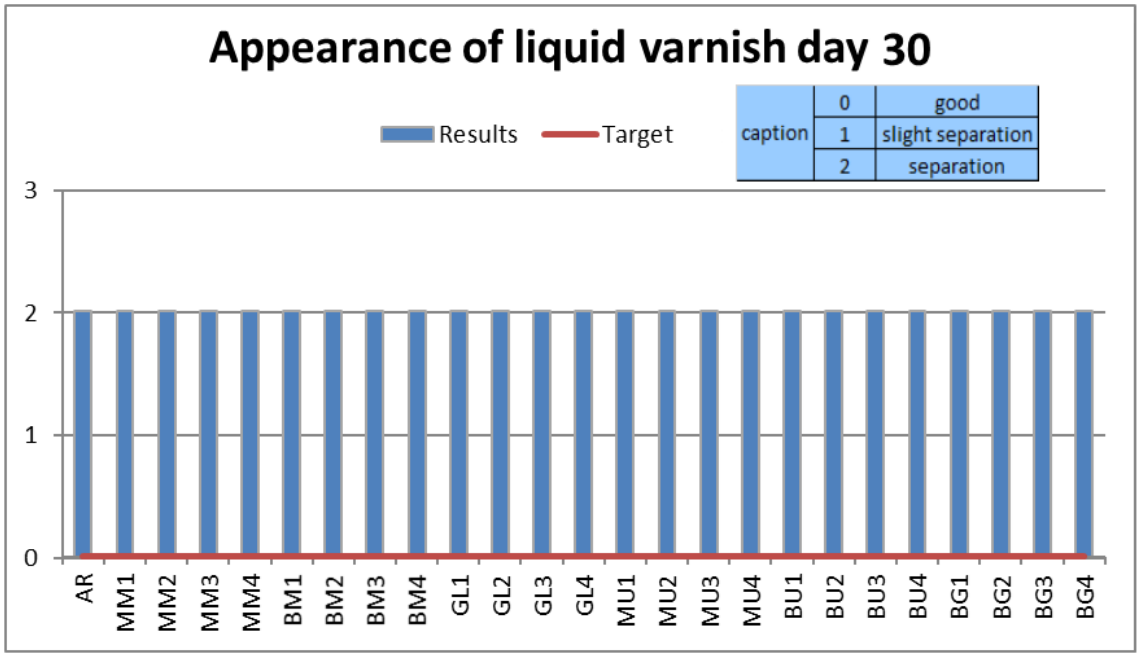



**Figure S7.** Results of the appearance for all liquid varnishes 30 days after production

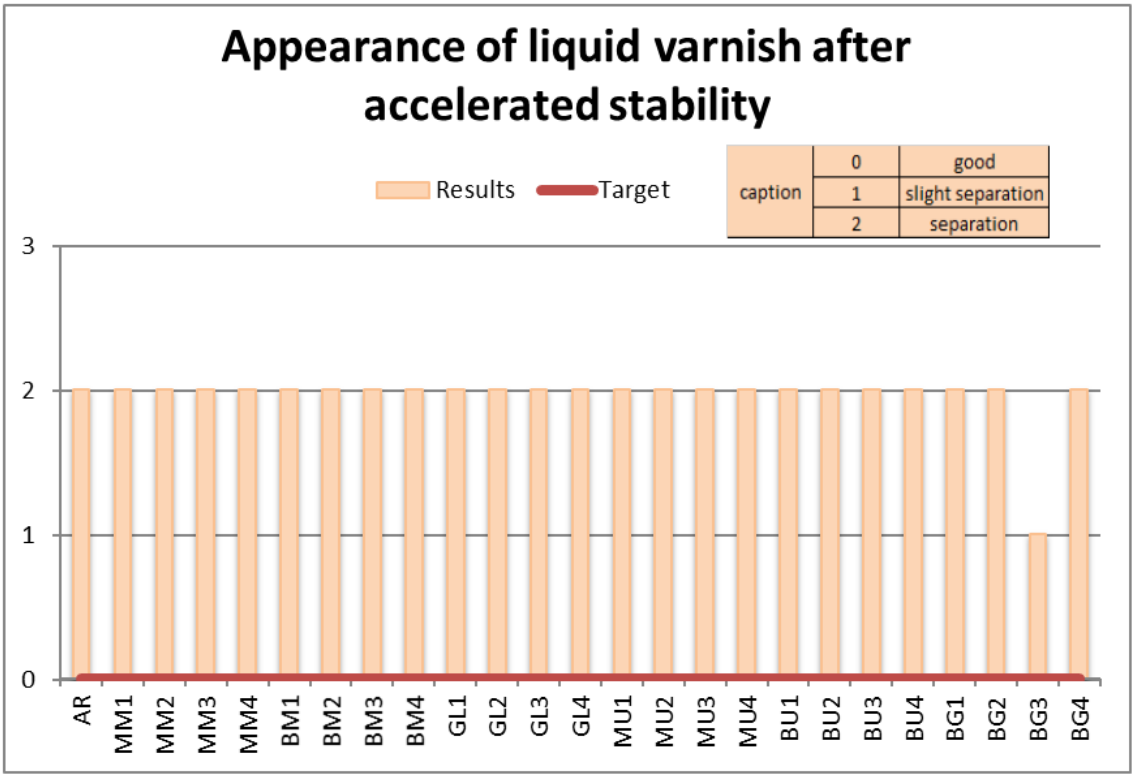



**Figure S8.** Results of the accelerated stability for all liquid varnishes (ASTM D869)

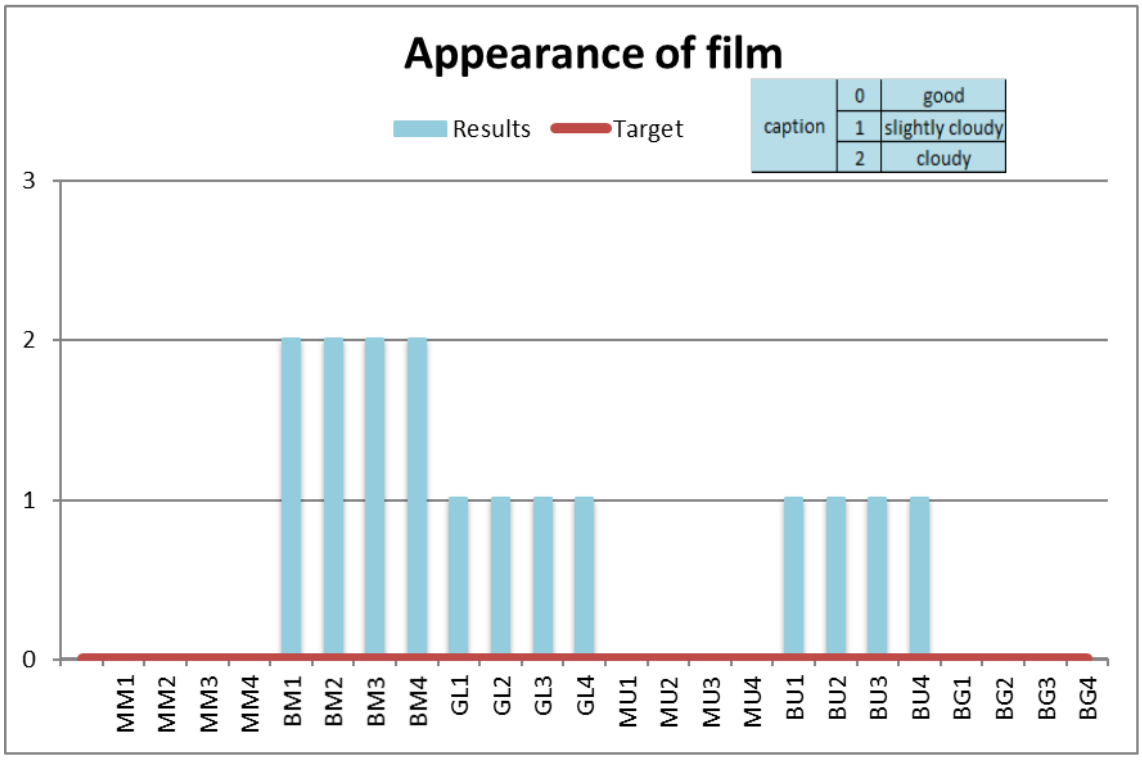
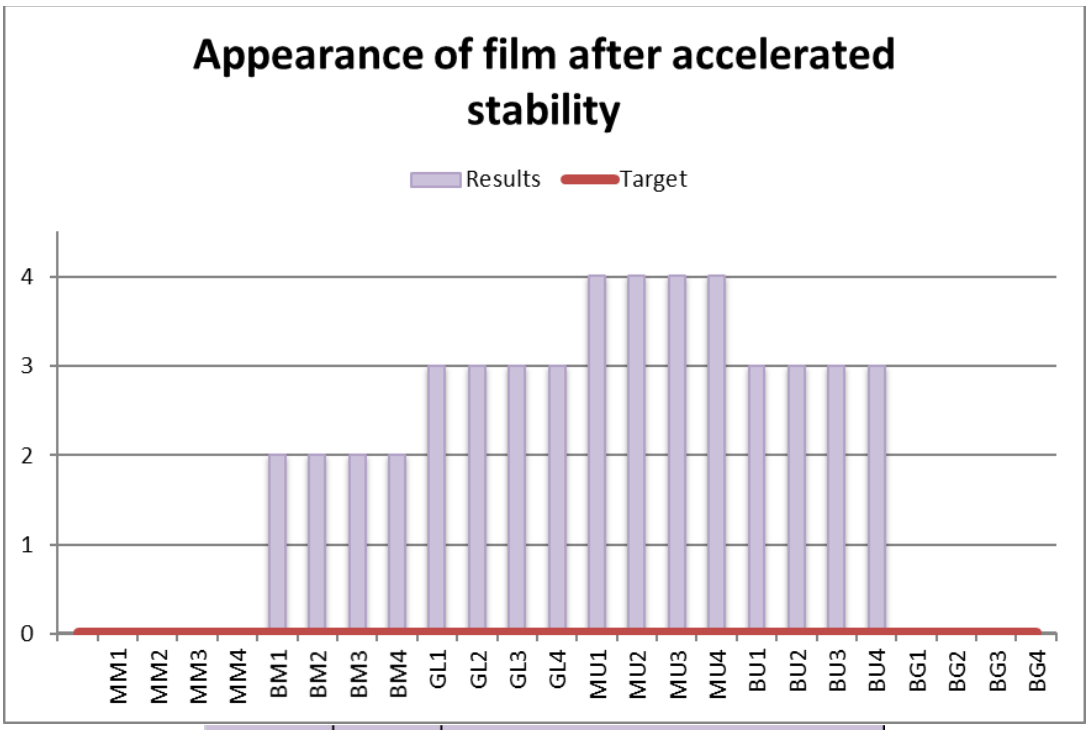



**Figure S9.** Results of the appearance of the applied film for all varnishes




| | | |
|---|---|---|
| caption | 0 | good |
| | 1 | craters |
| | 2 | slightly cloudy with craters |
| | 3 | slightly cloudy with orange peeling |
| | 4 | orange peeling with craters |

**Figure S10.** Results of the appearance of the applied film after accelerated stability for all varnishes

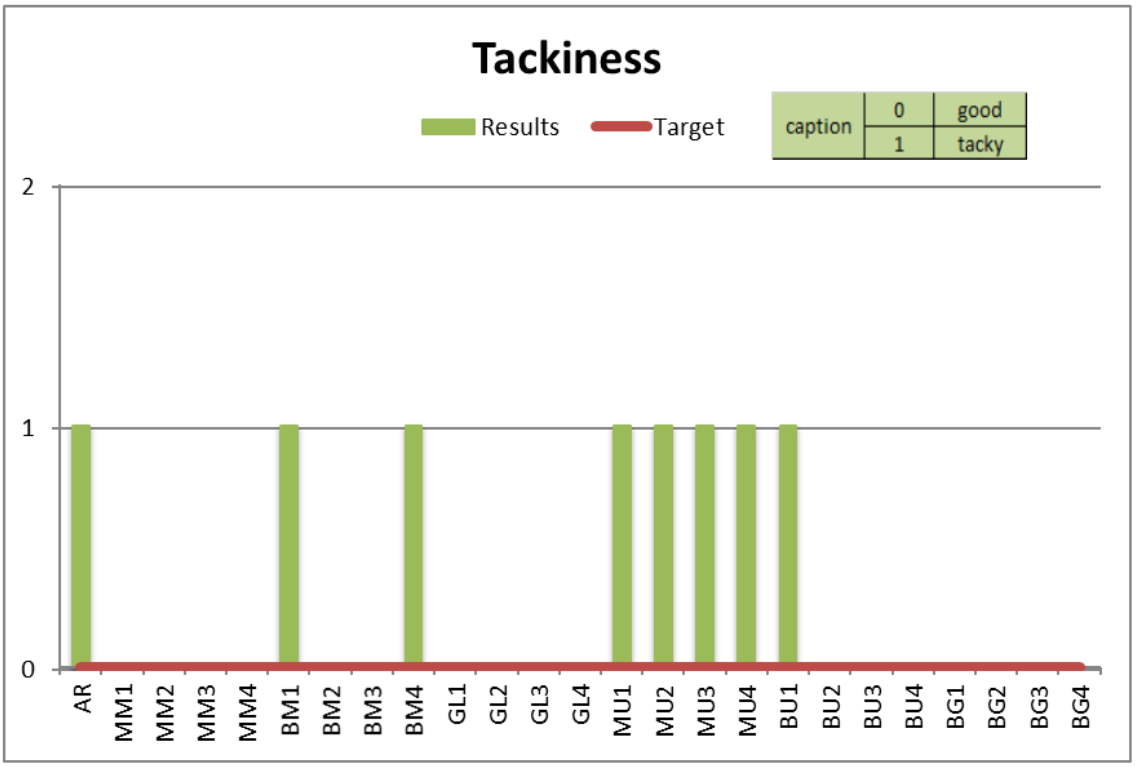



**Figure S11.** Results of tack determination to assess drying level for all varnishes

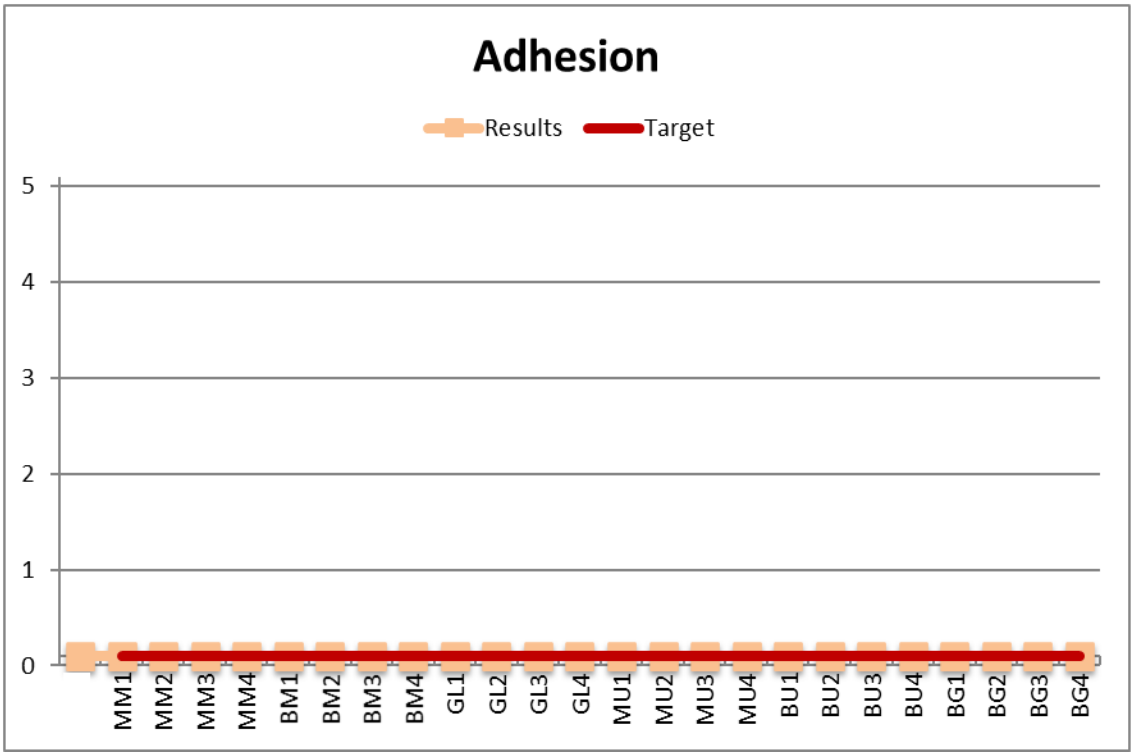



**Figure S12.** Results of the adhesion determination (ASTM D3359) for all varnishes

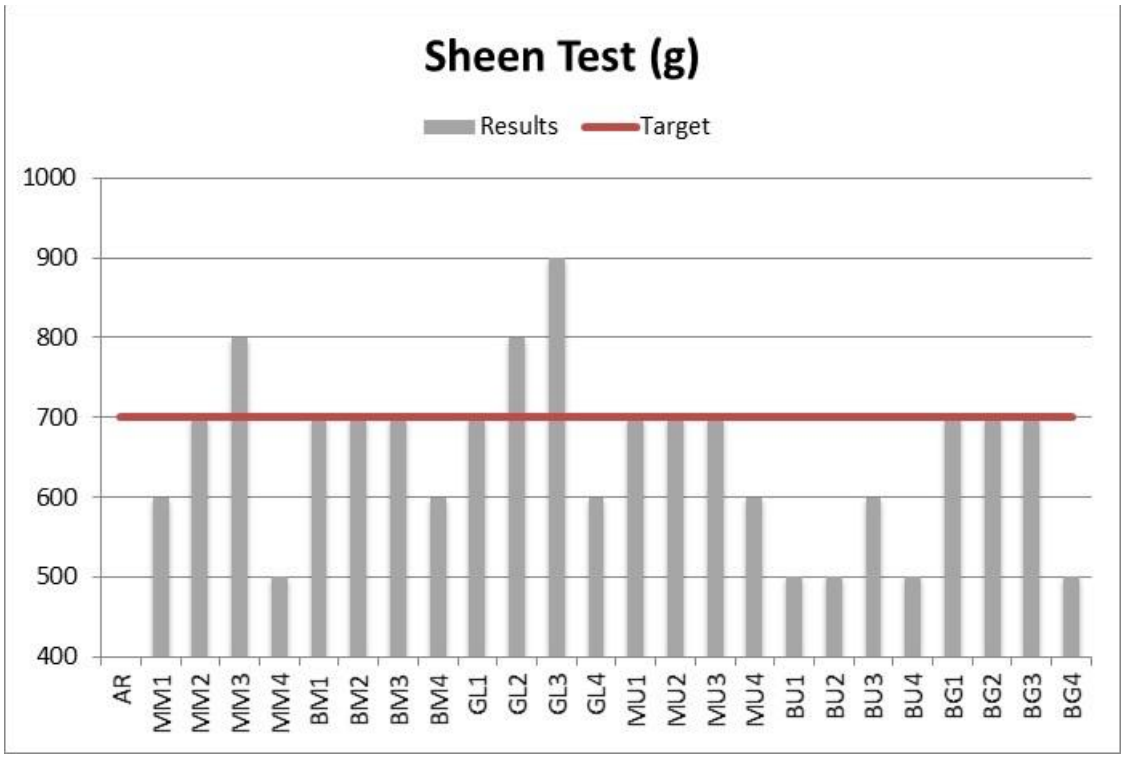



**Figure S13.** Results of the resistance to scratches using the SHEEN TEST method (ISO 1518) for all varnishes

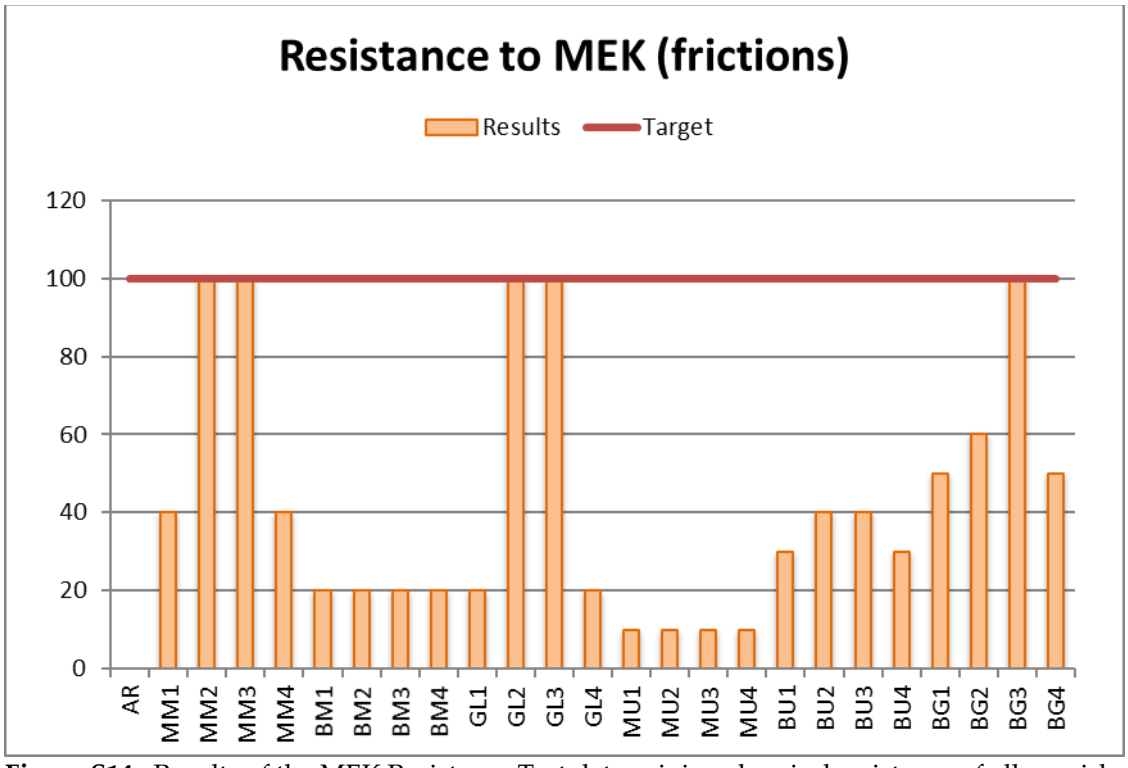



**Figure S14.** Results of the MEK Resistance Test determining chemical resistance of all varnishes (ASTM D5402)

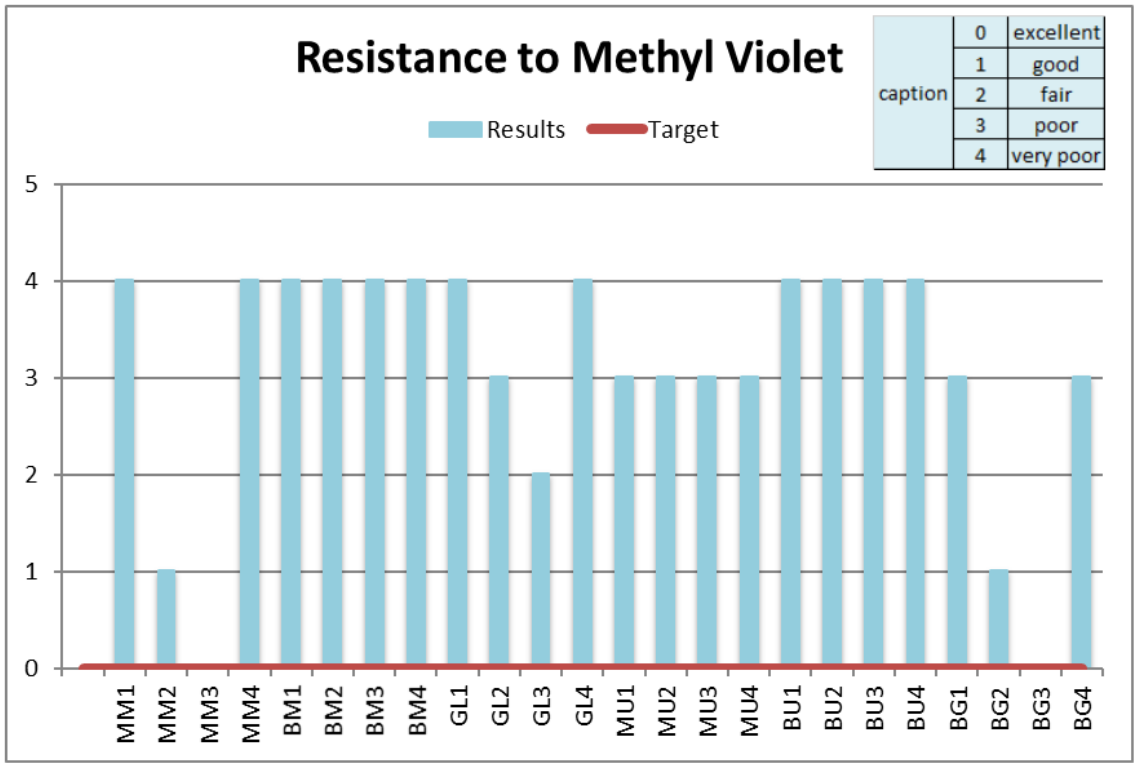



**Figure S15.** Results of the resistance to methyl violet determining curing degree for all varnishes

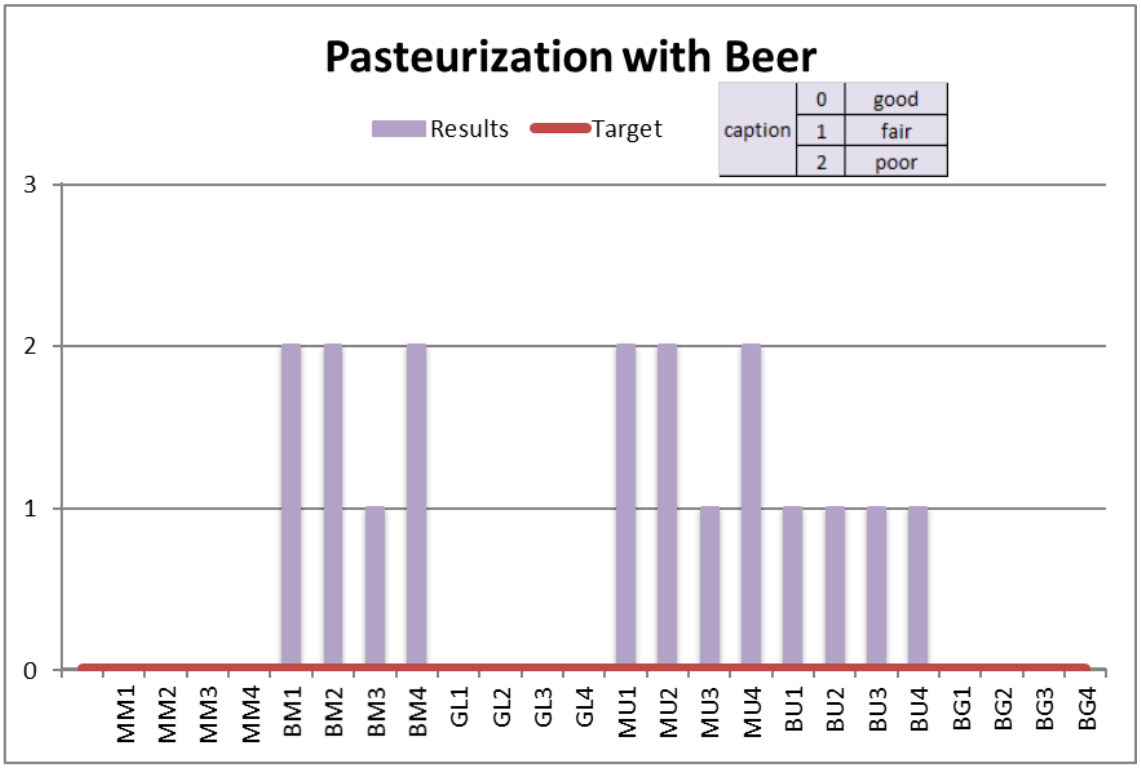



**Figure S16.** Results of the pasteurization with beer test for all varnishes

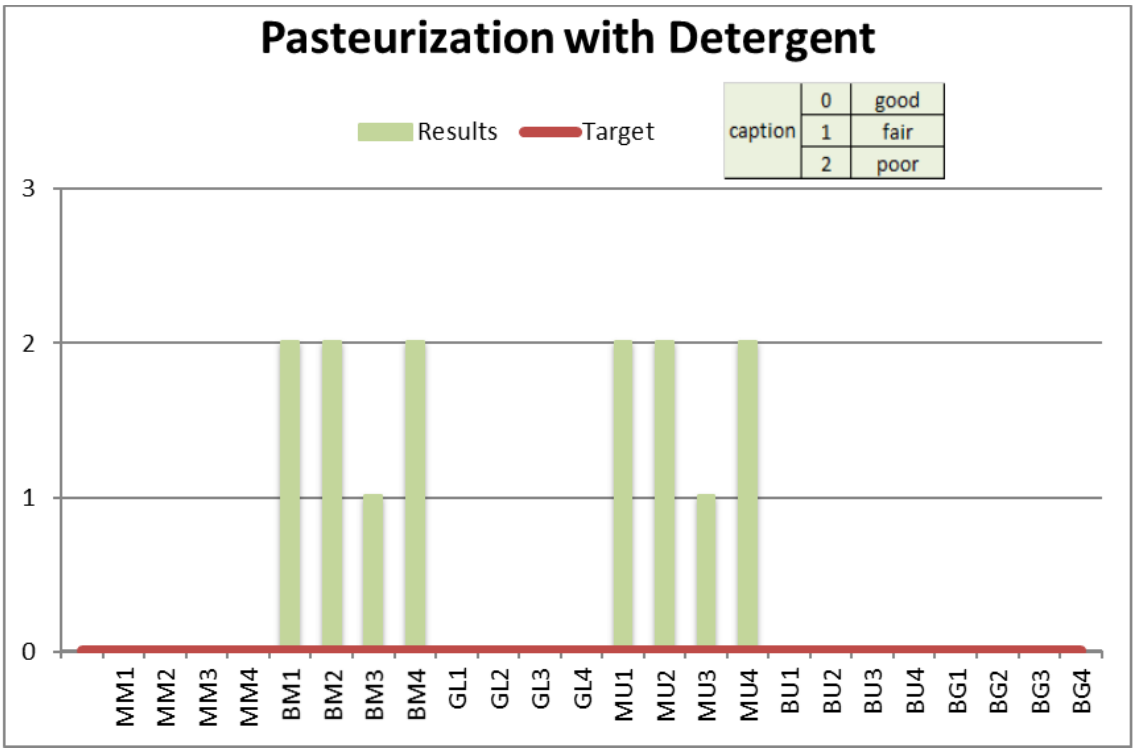



**Figure S17.** Results of the pasteurization with detergent test for all varnishes

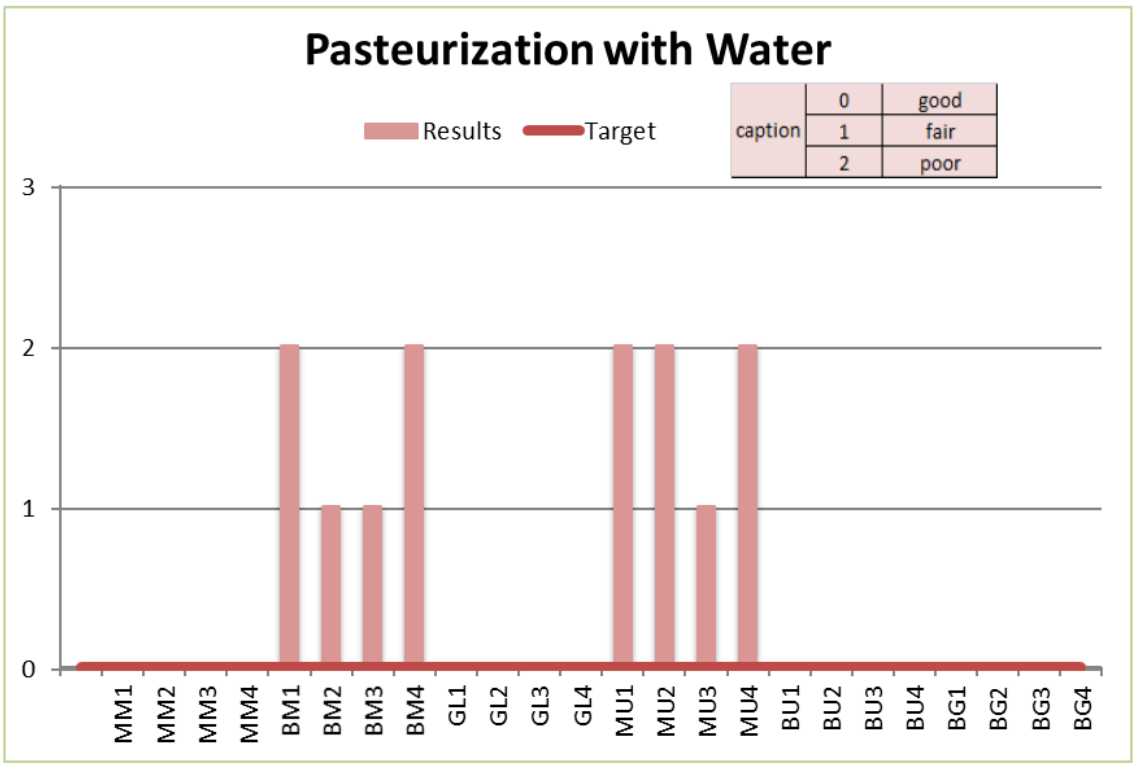



**Figure S18.** Results of the pasteurization with water test for all varnishes