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Reviewed Article:

Fine Pottery Chaîne Opératoire from the Bronze Age site of Via Ordiere, Solarolo (RA, IT): Experiments on the Relationship between Surface Treatments and Function

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The aim of this experimental work was to catch a glimpse of the pottery *chaîne opératoire*, particularly linked to the surfaces treatments applied, in order to better understand what

type of traces they could leave on pots and how they could differently affect the use of final products.

> Polished surfaces are able to retain liquids better and for longer times, managing to return a higher quantity of liquid. Neither shininess nor functionality of the pots have improved with milk application as a surface treatment. Polished surfaces are able to absorb less fat ingredients, measurably reducing the washing timing and the final washing result.

The starting point of the research was the ceramic assemblages from the archaeological site of Solarolo (Ravenna, Italy). The village dates from the Middle Bronze Age to the Late Bronze Age, for a period of approximately 500 years. The excavations and surveys done in the surrounding area led researchers to understand that the site covered seven hectares, near the Santerno River, and was divided into different occupied units. These units were scattered on an ancient riverine ridge, now known as Paleodosso di Bagnara (See Figure 1). In the best-preserved area, the excavations revealed important information about the living practice of the community, particularly displayed by the thousands pottery sherds which have been found to date. In fact, the quantity of pottery unearthed in every archaeological campaign is outstanding and encouraged the team who worked in Solarolo to attempt an experimental approach (Zurzolo, 2016). Thus, many pottery manufacture trials have been done, shaping-vessels, applying different surfaces treatments and decorations, and firing in experimentally made kilns. All these tests, together with the impressive archaeological materials discovered, highlights Solarolo ceramic's particular features, as it represents a fusion between separate elements. These mirror different cultural manifestations, known as *facies*, and identified as *Terramare* and *Grotta Nuova* (Cattani, 2009; Cattani *et al.*, 2018; Mannino, 2018; Zurzolo, 2016).

The focus of the research has been on a determined vessel's class, known as fine, or dining, pottery. This is generally identified by open shapes, very thin walls, and surface treatments which make pots more valuable and enhance their functionality. Moreover, the dining pottery can also be considered as fine thanks to its mainly temper free clay mass (Rice, 2015, Skibo *et al.*, 1997). Among the archaeological sherds from Solarolo, two different types of fine mass were observed: one of them displayed several types of small and rare inclusions while the other brought to mind the "temper free" clay mass identified in Monte Castellaccio, Imola (Amadori *et al.*, 1996, Cannavò *et al.*, 2017). Furthermore, preliminary examinations suggested that one of the main differences between dining and storage pottery was the amount of inclusions, which was reduced in the first class (Mannino, 2018) (See Figure 2). The starting point of the experimentation was a specific shape in the dining vessels class - the *carinated bowls* - both because it represented one of the most attested types in the archaeological record and it was easier to shape in bulk quantity. Once the shape was fixed,

the first issue is the choice of the clay mass, which is generally affected both by the manufacturing technique chosen and the pot's future function. Preliminary tests have been conducted using several clays collected directly from the site of Solarolo. The results showed the clay used in Solarolo pottery was different from the one collected from the site itself. The most similar type of clay has been identified as the one extracted from the bottom of the canal during the 2006 campaign. It was a light grey-blue clay (See Figure 3) and a comparable one has been found in a Pliocene outcrop around the first hills of Cesena, in Mercato Saraceno.

After these preliminary experiments, other tests have both been done with the experimental clay extracted, as well as an industrial one, to compare the different responses between the two. The molding technique has been selected to shape the experimental vessels thanks to the observation of the archaeological remains. In fact, the walls thinness and the continuity shown by the entire carinated bowls profile suggested the use of this technique. Once dried, different surface treatments (refining, smoothing or polishing) have been applied. Thirteen carinated bowls have been shaped, five with the experimental clay and eight with the industrial one, two of which were also treated with milk. They have been worked with different instruments, such as beech wooden spatula, horn spatula and awl, flint and agate pebbles, and wool. These instruments have been chosen according to the bibliography, the archaeological remains, and the studies conducted on archaeological traces (Rice, 2015; Van Gijn, Lammers-Keijsers, 2010). The particular use of wool and milk, used to moisten the surface before polishing, has been tested to guarantee a better final burnished surface. Before applying the surface, treatments listed, the external surfaces were worked from the beginning of the process using either fingers or a wooden spatula (La Torre, 2018).

Here are the treatments chosen, and the instruments used (See Figure 4):

- hand-shaped, wood smoothed, and pebble polished for the first trial, which has then been used as the mold to shape the others;
- refined by fingers (one of each type of clay);
- wood smoothed (one of each type of clay);
- wood smoothed and pebble polished (one of each type of clay);
- horn smoothed (one of each type of clay);
- horn smoothed and pebble polished (one of each type of clay);
- horn smoothed and pebble polished, milk during the leather hard state and pebble re-polished (industrial clay);
- horn smoothed, pebble polished, milk when it was totally dried and wool re-polished.

Smoothing represented the second surface refinement and it has been done when the drying phase was just barely started. Polishing was started at the leather hard state of the vessels or

later. In fact, all the trials showed that pots surfaces could be polished more than once and a surface previously worked responded better to a second treatment, thanks to the higher level of drying achieved (See Figure 5). Each of the surface treatments applied reflected a specific function of the pot, which meant a different degree of liquid absorption, waterproofness, and washability, as will be detailed later.

Once all the pots dried, they were fired. Only the mold has been experimentally fired in a Basilicanova-type kiln built in Solarolo (Cattani, 1997). The others were fired in a modern kiln in the Archaeological park of Montale (Modena), trying to replicate temperatures and conditions observed in the experimental firing.

After firing, the vessels were ready to be tested for their waterproofing (first test) and washability (second test). Water has been chosen for the first one (See Figure 6), which has been observed at different stages (1 h, 5 h, 12 h, 24 h).

The quantity of water selected for the first experiment was 150 ml. Before starting the trial, vessels were weighed to allow the amount of water absorbed during the entire process to be measured. After this first experiment, smoothed vessels were the first ones showing traces of dampness, from the pot corner point. The same occurred shortly after to the just-refined pots and then to the polished ones. Thus, there was not a deep difference between the refined and the smoothed vessels, while a greater one, both in the quantity of water absorption and in timing, was displayed by the polished pots that absorbed less water and in more time and compared to the others. In the following table it is possible to observe the remaining water quantity in millilitres (See Table 1).

	H_2O (ml)	1h (ml)	5h (ml)	12h (ml)	24h (ml)
Experiment n.1	150	119.3	110.5	100.9	97.9
Experiment n.2	150	119.1	106.6	99	95.3
Experiment n.3	150	121.2	106.2	102	100.4
Experiment n.4	150	123.5	114.3	109.2	107.5
Experiment n.5	150	120.1	105.8	99.8	98.1
Experiment n.6	150	116.1	104.9	101.4	99.4
Experiment n.7	150	121.9	109.5	108.9	106.7
Experiment n.8	150	118.4	107.4	97	94.3
Experiment n.9	150	118.4	105.1	99.8	98.1
Experiment n.10	150	124.5	110.8	103.8	101.6
Experiment n.11	150	125.8	112.7	112.7	109.8
Experiment n.12	150	128	116.4	114.4	111.9

TABLE 1. VALUE CONCERNING THE WATERPROOFNESS AND IMPERMEABILITY TEST.

The second test, linked to the pots surface permeability and washability through water, has been carried out employing two fatty ingredients, soup and milk (See Figure 7). It has been done both in a ten minutes span time, which has been imagined as a direct consumption period, and in an hour span time, thought as a sort of storing time. The ten minutes milk- trial showed:

- refined pots displayed a thick halo where the pots have contained milk;
- smoothed vessels and the milk treated ones showed something similar, but the milk halo was less thick than in the previous ones;
- polished pots showed only a darkened surface due to the humidity of the surface itself.

Right after, the washability test has been verified, using water and a wool cloth. The refined pots required a longer timespan to be washed and they still showed traces once dried. The smoothed vessels required less than half of the time to be washed, even if traces were still visible after the drying stage. Furthermore, vessels made with the industrial clay required more time to be washed than the experimental ones. A completely different result has been observed in the two pots polished with pebbles and treated with milk. The first one shared a similarity with the smoothed pots while the second one with the polished vessels. The one-hour time trial didn't show greater differences, apart from the washability which, of course, required more time. (La Torre, 2018).

Another washability test was made with soup left in the vessels for ten minutes, the supposed time required to be eaten with a wooden spoon. The traces were deeply different among the samples:

- the two refined pots were completely soaked; thus, they needed to be submerged in water for a certain period of time and to be energetically washed, and some traces were left anyway;
- the smoothed pots showed less deep and scattered soup remains; so they didn't require a dunk time even if they needed to be energetically washed;
- the polished ones displayed the same homologous colour even after the consumption of the substance, and the washability degree was quite high. No dunk was required and just flowing water could take away the traces left on the surfaces, which had hardly been permeated;
- the milk-treated sample showed a behaviour similar to the smoothed vessels;
- the milk and wool- treated pot showed a behaviour closer to the polished samples.

Furthermore, the refined pots changed also their colour after the washing stage, and they even showed traces left by the wooden spoon. The one-hour trial has displayed similarities to the ten minutes one: all the pots required a long dunk time in order to easily remove the soup traces, even if a short dunk time was enough for the polished vessels. The milk- treated

test has been the worst for washability: it showed a darker colour after the washing, and visible traces of the wooden spoon. This suggested that sometimes it can be hard to distinguish treatments traces from usage ones.

It has also been possible to compare similarities and differences between the archaeological traces left by the different surface treatments applied and the experimental ones. It has been observed that the refined pots show clearly traces of the fingerprints used to do so; a hard instrument, such as a horn one, leaves thin parallel stripes, while a wooden instrument leaves larger parallel stripes. Parallel stripes can be seen also when a pot has been pebble polished, and sometimes parallel ruts can be observed as well. Moreover, if a vessel is just partially pebble polished, its surface shows irregularities; these become deeper traces if tempers have been moved by the pebble on the vessel surface itself.

To sum up, polished surfaces are able to retain liquids better and for longer times, managing to return a higher quantity of liquid. Neither shininess nor functionality of the pots have improved with milk application as a surface treatment. Polished surfaces are able to absorb less fat ingredients, measurably reducing the washing timing and the final washing result.

Any surface treatment couldn't only be used to make more valuable pots; in fact, as it required technical knowledge and a long time for the execution, it was used to enhance the vessels functionality as well.

Keywords ceramics
methodology

Country Italy

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FIG 1. SOLAROLO (RAVENNA. ITALY) VILLAGE LOCATION. SOURCE GOOGLE MAPS

FIG 2A. FINE POTTERY TEXTURE FROM THE ARCHAEOLOGICAL RECORD. PHOTO BY ALICE ZURZOLO.

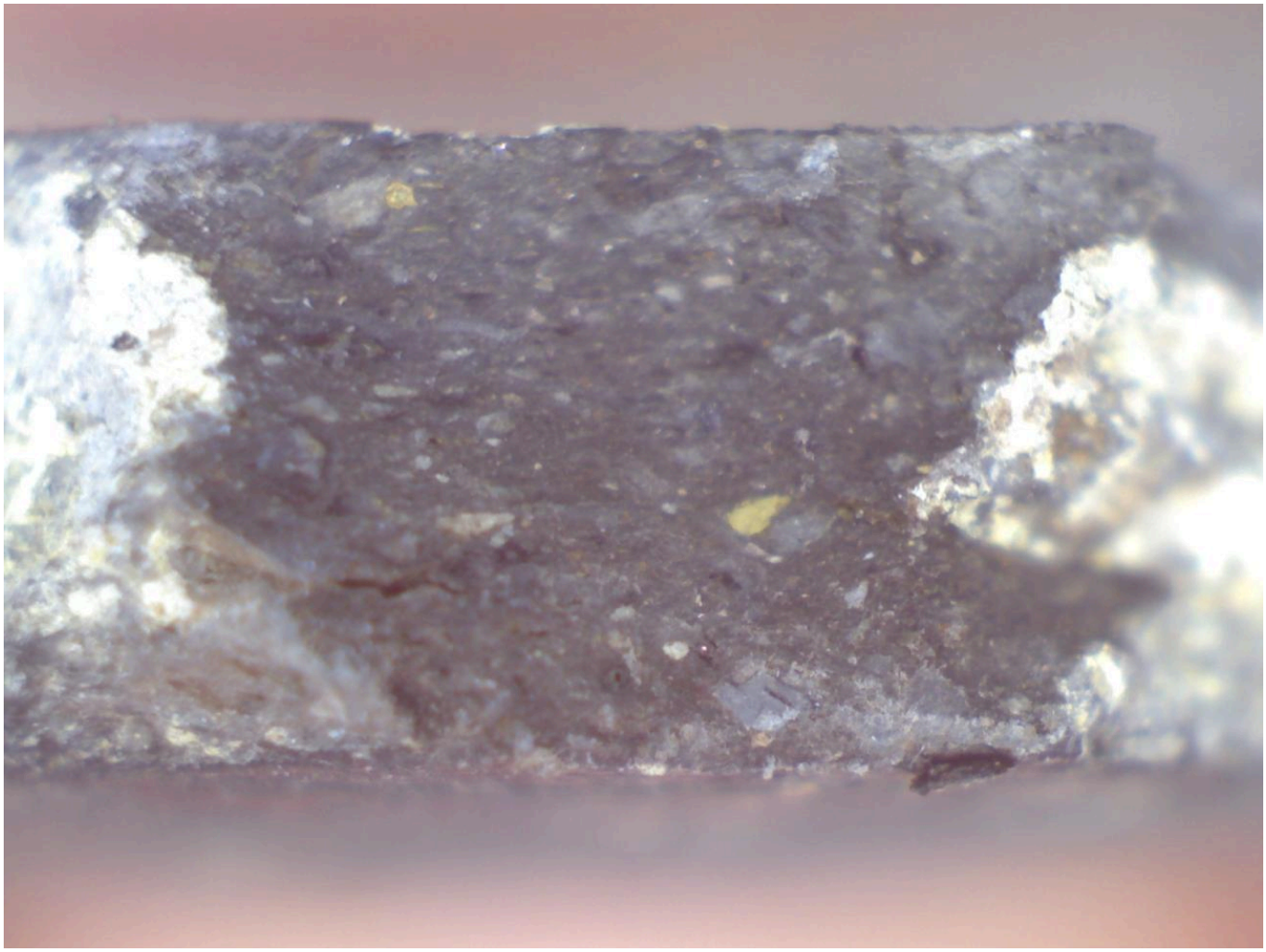

FIG 2B. FINE POTTERY TEXTURE FROM THE ARCHAEOLOGICAL RECORD. PHOTO BY ALICE ZURZOLO.

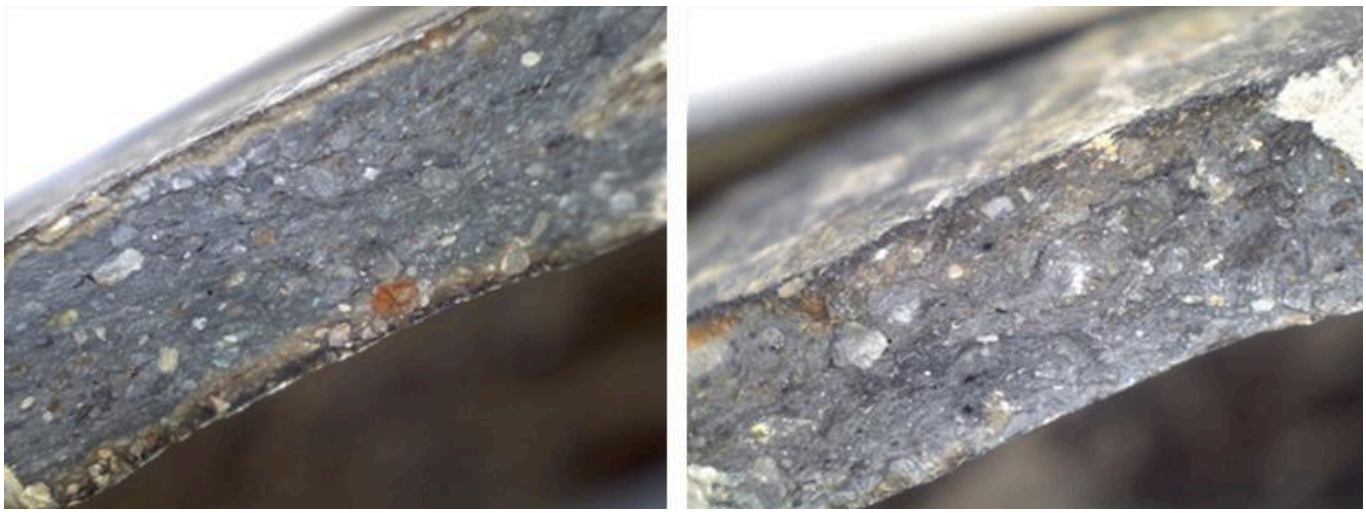

FIG 2C-D. FINE POTTERY TEXTURE FROM THE ARCHAEOLOGICAL RECORD. PHOTO BY ALICE ZURZOLO.

FIG 3. PHOTO OF THE VILLAGE CANAL DURING EXCAVATION. WITH INDICATION OF THE CLAY SUITABLE TO BE SHAPED. PHOTO BY ALICE ZURZOLO.

FIG 4. INSTRUMENTS USED. PHOTO BY ALICE ZURZOLO.

FIG 5A. REFINEMENT PROCESS. PHOTO BY ALICE ZURZOLO.

FIG 5B. REFINEMENT PROCESS. PHOTO BY ALICE ZURZOLO.

FIG 5C. REFINEMENT PROCESS. PHOTO BY ALICE ZURZOLO.

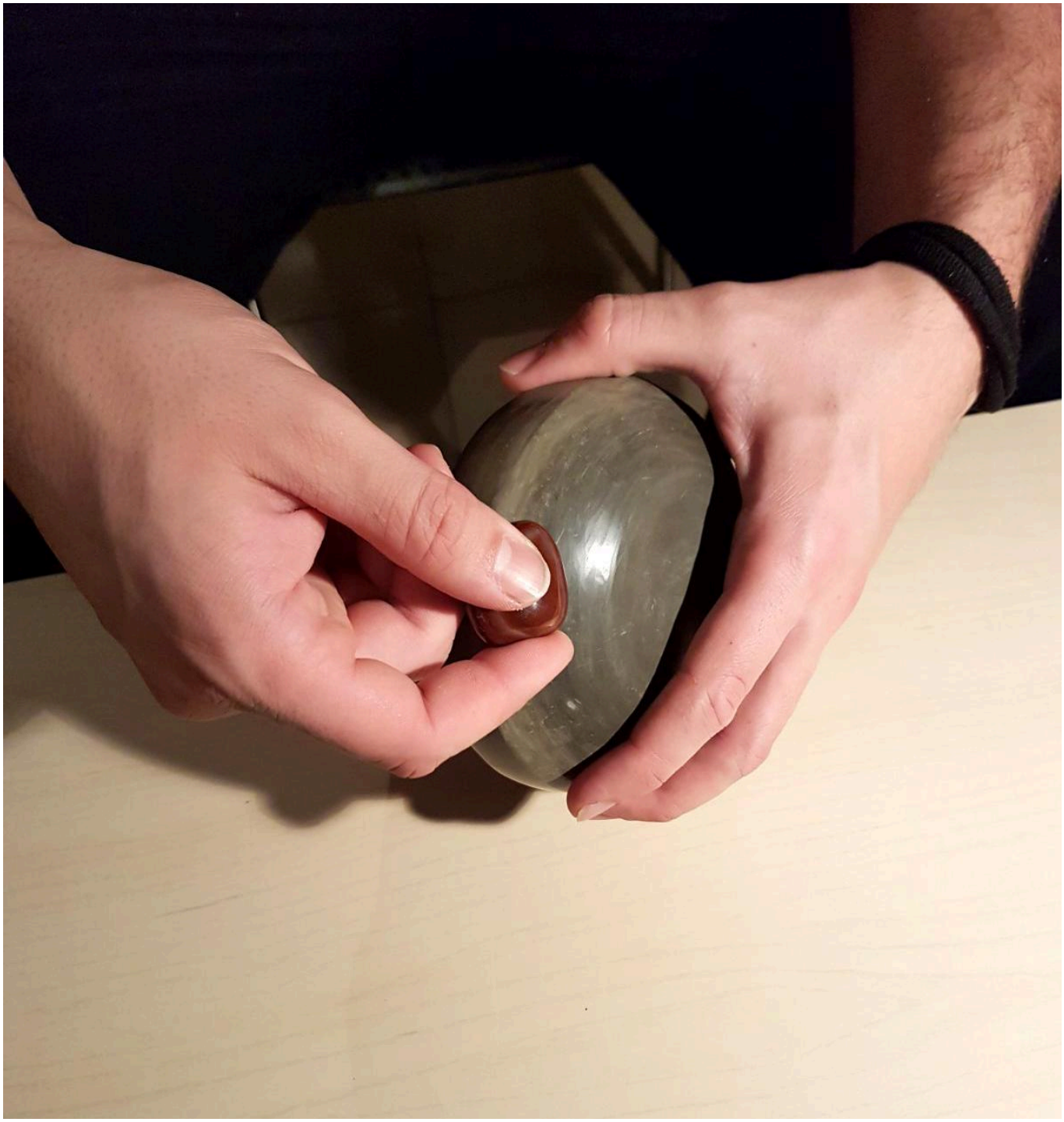

FIG 5D. REFINEMENT PROCESS. PHOTO BY ALICE ZURZOLO.

FIG 6. WATER ABSORPTION DURING IMPERMEABILITY TEST. PHOTO BY ALICE ZURZOLO.

FIG 7A. PERMEABILITY AND WASHABILITY TEST WITH SOUP AND MILK. PHOTO BY ALICE ZURZOLO.

FIG 7B. PERMEABILITY AND WASHABILITY TEST WITH SOUP AND MILK. PHOTO BY ALICE ZURZOLO.