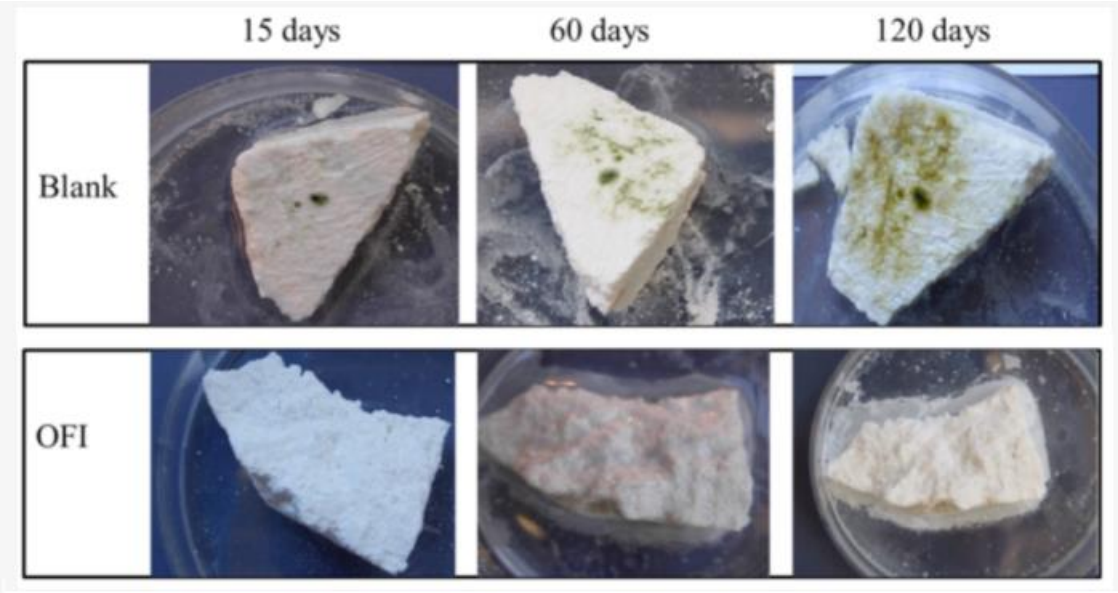
OPUNTIA F.I.-MCL ORGANIC COMPOUND

The need for compatible materials for the preservation of cultural heritage has resulted in the revival of lime-based mortar technology and other applications. Opuntia is a 100% organic compound ideal for preserving old walls, for mixing into lime coatings and in mortar elaboration.

Recent studies and experiments carried out in Italy and Mexico have demonstrated that the addition of Opuntia at water replacement concentration between 4-8% as suitable for durability enhancing applications in cement-based mortar. The analysis of mortar added with primal acrylic resin showed comparable compactness to the mortar added with the same percentage of Opuntia.

Specimens of lime mortars inoculated with bacteria, fungi and a photosynthetic biofilm added with 2.5% of Opuntia sealer have been analysed to determine colour change (colorimetry), cohesion (ultrasound measurements), integrity (X-rays) and bio-receptivity (microbiological tests) in order to investigate long-term durability.
The internal structure of the specimens added with Opuntia termed as bio-mortar shows better compactness, no colour change and no microbial growth even after aging.



These results indicate that the addition of Opuntia improves the mortar qualities,
due to very low bio-receptivity, mainly resulting from the presence of a higher content of hydro-soluble phytomolecules such as polyphenols, thus making this organic compound a sustainable alternative to chemical additives.

Opuntia contains a combination of phytochemicals which are non-artificial anti-fungal substances as well as Indicaxanthin – a strong anti-oxidant, and Betanin. The latter is an antimicrobial and natural colouring agent.

From a chemical point of view, Opuntia is a complex carbohydrate with a molecular weight between 1.5 and 4×10^6 g/mol, composed of a variable amount of arabinose (24.6–42%), galactose (21–40.1%), galacturonic acid (8–12.7%), rhamnose (7–13.1%), and xylose (22–22.2%). These carboxylic groups react with divalent cations to form an egg-box structure, which allows water retention in plants. As an additional component, it contains mono and divalent cations, DNA, proteins in small amounts, and as stated earlier, phytomolecules, such as polyphenols.

This chemical composition makes Opuntia an excellent additive to lime, which may prevent surface breaks of mortars guaranteeing the desirable moisture, promote the plasticity of the mortar allowing its use in thin layers and to act as a consolidator thanks to its high viscosity.

A separate recent scientific investigation to determine whether Opuntia increases durability for cement-based materials exposed to CO2-laden environments has also rendered very positive results. The use of this organic compound in cement-based material applications has shown good performance when these materials are exposed to chloride-laden and other hazardous environments where most of these construction materials are naturally exposed: marine, urban, and industrial.

Steel-reinforced mortar prisms containing Opuntia at different addition levels (0%, 1.5%, 4%, 8%, 42%, and 95%, by water mass replacement concentration), were exposed for 14 years (5110 days) in a natural CO2-laden environment. Linear polarization resistance measurements were performed in a wet–dry cycle (between 5020 and 5110 days of age, after mortar fabrication) to determine the possible corrosion-inhibiting effect of Opuntia additions.

Little corrosion-induced cracking was observed in carbonated mortars with Opuntia additions when compared with the carbonated control mortar that showed high corrosion-induced cracking. The electrochemical results showed corrosion-inhibiting efficiencies for steel in carbonated mortar with Opuntia additions of 40–70% for low concentrations (1.5% and 4%), and 70–90% for medium and high concentrations (8%, 42%, and 95%). Experimental findings suggest that adding Opuntia might be useful as a corrosion inhibitor for steel in carbonated cement-based materials (i.e., mortar) because corrosion rates and cracking initiation/propagation were considerably decreased.

The inherent properties of this organic compound also make Opuntia an excellent preserving agent for Malta's porous limestone. It has been crafted, tried and tested successfully for several centuries since its introduction in the mid-sixteenth right up to the mid-twentieth centuries respectively. Since then, social and cultural changes have led to a general consumer shift and dependence on chemical and artificial products.

Maltese limestone comes in different grades, depending on location and depth of extraction. It is soft and easy to work with, and ages well by developing a natural patina unless exposed to very high levels of humidity, rising damp or a heavily polluted atmosphere.
Being a soft-stone, it is also fragile and reacts negatively once its patina is removed due to surface interventions that could involve cutting, chipping or sanding down.
Such interventions typically cause the stone surface to start flaking and dusting within a few weeks or months and eventually deteriorating considerably after a few years.

Trials held in order to determine whether this issue could be avoided by the application of Opuntia have rendered very positive results. Surface interventions were made on stones that were originally extracted and hand-tooled around 150 years ago having a thick patina and on other mechanically cut stones aged 50 years with a lesser patina.
In both instances, the samples were purposely cut or had their original outer surface shaved down, then treated with Opuntia. Regular monitoring held over a period of 12 months has shown that no deterioration or adverse effects such as flaking or erosion have occurred whatsoever.

Furthermore, the compound appears to have encouraged the reformation of a new patina where interventions were made, while enrichening the existing patina on the rest of the treated surfaces.

The images above show stones after one year of being cut. The first and central photos demonstrate the results following Opuntia treatment in comparison with the photo on the right featuring an untreated stone.

Aside of these positive results, another study was carried out in order to determine the long-term effects of Opuntia treated limestone walls. This exercise comprised careful observation of older structures built during the same time span. Walls known to have been treated with Opuntia were compared to others that were not.
Several factors including the quality of the stone, location, exposure to light and other external factors were taken into consideration. In most cases the difference was clear and walls treated with Opuntia were found to be in much better condition despite no maintenance or re-application of this or other compounds for at least 50 years.

Comparative images showing Opuntia treated (left) and untreated walls (right)

Harsien Patrimonju Mosti has, after due research and consultation, successfully managed to retrieve and revive the recipe and methodology of recreating this artisanal compound made out of prickly pear plants using traditional methods.
Opuntia is made to order and being a natural product with no artificial additives, should be stored away from direct sunlight, kept in a cool environment and ideally applied soon after production.

It is a chlorine-free water-based solution with an oily texture and high viscosity. Once dry, the result is a matt and odourless coating with an indistinct reddish hue that pales slightly over time, protecting and enhancing the natural stone patina, especially on walls facing the sun.

Application

Opuntia is preferably applied copiously using a large paintbrush since this affords better penetration. We recommend two initial coatings spaced within a few hours, however the number of coatings required and coverage ratio may vary depending on the age, type and location of the wall surface. All these factors affect the porosity and subsequent absorption rate of the stone, and every wall is different. Recoating after 2-3 weeks is advisable and may be required periodically as part of a regular maintenance and conservation schedule.

Surfaces must be cleaned properly before use with distilled or well water. Normal tap water should be avoided since this medium is laden with traces of chlorine, sodium and other potentially damaging substances, often making it a latent factor in stone deterioration. Opuntia may be used on all stone surfaces, both indoors and out, including walls, flooring and free-standing structures.

If used as an additive to lime mortar or other applications, the same proportion of Opuntia as resin-acrylic based sealers is recommended.

Additional Notes & Disclaimers

The technical and scientific information present in this datasheet has primarily been sourced from two peer-reviewed reports published in 2021 by the Molecular Diversity Preservation International (MDPI) Basel, Switzerland. Further details upon request.

Opuntia is crafted using 100% natural ingredients in controlled conditions and according to researched original methods and techniques.
No tap water is used to avoid chlorine and any other chemical traces typically present in this medium.
It is sustainable, non-toxic, non-flammable and environmentally friendly.
Compound colour may vary slightly from one batch to another, but this not affect the end result or quality of the product.
Some sedimentation may occur.

Since this product is used under conditions that are beyond our control, the manufacturer shall not be responsible for results obtained.
Liability is restricted to the replacement of any material proved faulty and the manufacturer is not responsible for loss or damage arising from incorrect storage or usage.
Determining the suitability of the product for any intended use shall be the sole responsibility of the user.

This document was prepared in April, 2021 and may be subject to further augmentation or revision accordingly.