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The production of handrub sanitizer, an emotional and singular story

Gumersindo Feijoo[1], Francisco Otero[2], Juan Manuel Garrido[1]*

[1]BioGroup. Department of Chemical Engineering. CRETUS. School of Engineering. Universidade de Santiago de Compostela, 15782 Santiago de Compostela.

[2]PARAQASIL Group. Department of Pharmacology, Pharmacy and Pharmaceutical Technology. Faculty of Pharmacy. Universidade de Santiago de Compostela, 15782 Santiago de Compostela.

(*Corresponding author: juanmanuel.garrido@usc.es)

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Abstract

In March 2020, most countries went into lockdown and the population was confined to fight against the unstoppable pandemic transmission of SARS-CoV-2. Beyond the measures that the university itself had to put in place to continue its activity, evolving from face-to-face to purely virtual teaching, there was great alarm about the uncertainties of the pandemic. One of the elements that generated concern was the availability of material to carry out adequate prophylactic prevention in the transmission of the virus. The preventative measures that the health authorities were transmitting revolved around three fundamental aspects (i) the use of Personal Protective Equipment, mainly FFP2 type masks; (ii) regular hand washing, with the availability of handrub sanitizer playing an important role; (iii) ventilation of rooms.

Figure 1. Images on the manufacturing process and the final users of the product.

Two of them require prior logistics that cannot be improvised from one moment to the next, which meant that there was a great shortage of masks and handrub sanitizer. At that time, the university undertook two actions: (1) donating to the health service all the material we had in stock (PPE -gloves, mask- and PCR reagents) and (2) adapting our facilities to be able to manufacture handrub sanitizer and meet the initial needs of the public health system, in order to carry out the motto of the VII World Congress of Chemical Engineering held in Glasgow in 2005: "Engineering for LIFE".

We created a team of Master's and PhD students together with technical staff and faculty from the disciplines of Chemical Engineering, Pharmacy and Pharmaceutical Technology, Analytical Chemistry and Organic Chemistry to transform the pilot plant of the School of Engineering into a production facility. Figure 2 shows the results achieved: 17,841 500 mL bottles, i.e., a total of 8,920.5 L divided into 2,739 bottles with isopropyl alcohol-based gel and 15,102 bottles with ethanol-based gel.

For the manufacture of the handrub sanitizer, the formulation recommended by the World Health Organization (WHO) was adapted, using either ethanol or isopropyl alcohol, distilled water, glycerin, and hydrogen peroxide. The original formulation of the handrub sanitizers contain either 75% or 80% v/v isopropyl alcohol or ethanol, respectively; 1.45% glycerol; 0.125 hydrogen peroxide, and water to complete the volume. Nevertheless, the production of this alcoholic solution involved making various decisions, derived from the material means, equipment and human resources available. In this sense, many of the knowledge and keywords, commonly used for the chemical engineering teaching, should be used with a practical objective.

Optimization of the product quality: The WHO handrub sanitizer formulation, however, entailed the risk of losing the product by dripping, or even the risk of using to much product during its application by its low viscosity. Thus, the application of a appropriate organic polymer, carboxy-methyl cellulose (Methocell E4M Premium; Dow Chemical) was considered in order to increase the viscosity of the product. We prepared different batches of the hydroalcoholic solutions of 17 cP, 27 cP, 70 cP and 110 cP that were tested by the members of the Production Team, for their characteristics, finding that it was better to use the more viscous products. The product with the highest viscosity notably compromised the duration of the whole process, and we found that the product of 50-70 mPa-s was suitable for application in hands (as a reference glycerol has a viscosity of 1500 mPa·s and olive oil of 100 mPa·s).

Mass balances: During the entire process, the overall mass balances of raw materials and finished product were carried out. Losses were less than 1%. Small errors in the weighing of materials and losses of the processed product (spills) can justify the imbalance.

***Rate*-limiting step**: This concept, taken from the Chemical Reaction Engineering, was fully in force throughout the process. In our case, rather than referring to a reaction, it was caused by the limitations that we faced due to limitations in raw materials (alcohol, glycerin, hydrogen peroxide) or material means for packaging (cardboard boxes, labels, bottle dispensers, etc. .).

Safety and security: During the first moments of uncertainty caused by the pandemic, the decision to divide the volunteers into two different teams was taken, with schedules divided between morning and afternoon and without contact between them. This action would prevent the entire process from having to stop, due to the quarantine of the entire team if one of the volunteers became infected.

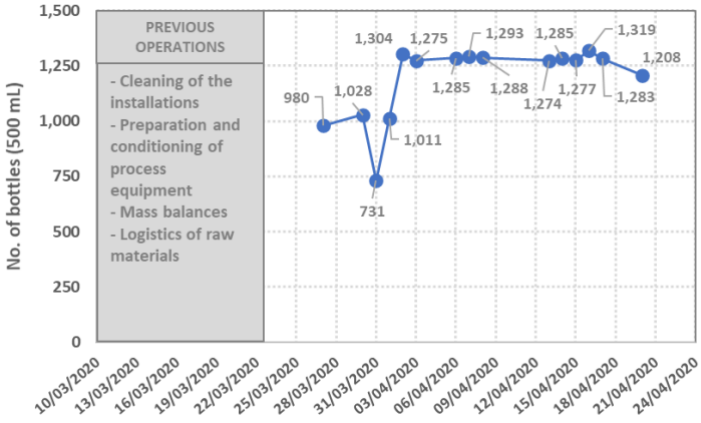

Figure 2. Evolution of the handrub sanitizer production at the USC.

Acknowledgements

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