Tomato-residue-based lacquers to coat the inside of cans and food packaging

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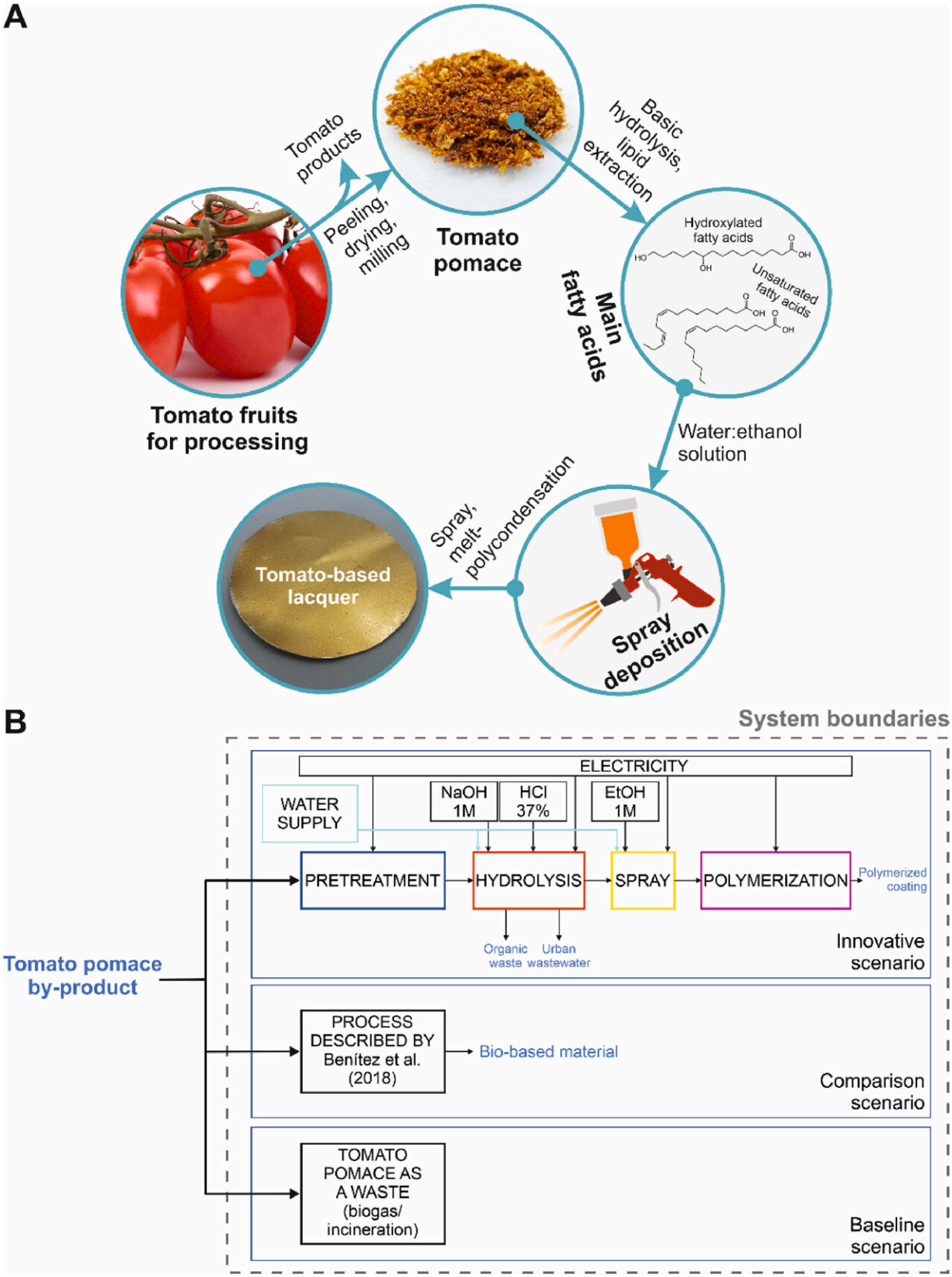
A
Tomato products
Peeling, drying, milling
Tomato pomace
Basic hydrolysis, lipid extraction
Hydroxylated fatty acids
Unsaturated fatty acids
Main fatty acids
Tomato fruits for processing
Water:ethanol solution
Spray, melt-polycondensation
Tomato-based lacquer
Spray deposition
B
System boundaries
ELECTRICITY
WATER SUPPLY
NaOH 1M
HCl 37%
EtOH 1M
PRETREATMENT
HYDROLYSIS
SPRAY
POLYMERIZATION
Polymerized coating
Organic waste
Urban wastewater
Innovative scenario
Tomato pomace by-product
PROCESS DESCRIBED BY Benítez et al. (2018)
Bio-based material
Comparison scenario
TOMATO POMACE AS A WASTE (biogas/ incineration)
Baseline scenario

A, schematic representation of the fabrication process of the tomato pomace-based lacquers for metal packaging. First, tomato fruits are processed to prepare different tomato products (e.g. sauces, soups, ketchup, etc.). The resulting by-product, namely tomato pomace, is hydrolyzed in basic media and the corresponding hydroxylated and unsaturated fatty acids from peels and seed, respectively, are extracted. These molecules are solved in a mixture of water and ethanol and sprayed on a metal substrate. Finally, a bio-based polyester is prepared by melt-polycondensation. B, system boundaries considered for the LCA. Credit: *Journal of Cleaner Production* (2022). DOI: 10.1016/j.jclepro.2022.135836

An international team of experts led by researchers from the research centers Instituto de Hortofruticultura Subtropical y Mediterránea "La Mayora" (IHSM-CSIC-UMA), in Malaga, and the Instituto de Ciencia de los Materiales de Sevilla (ICMS-CSIC-US), located in the Cartuja Science and Technology Park in Seville, has developed tomato pomace lacquers to coat the inner surface of metal food packaging, food and beverage cans, among others.

Currently, steel and aluminum are the main materials used to manufacture metal cans and containers. When these are in contact with food, they can corrode the metal and thus contaminate the preserved food. To avoid this, the inside of these containers is coated with a very thin protective layer to prevent this corrosion of the metal. This adhesive resin is called epoxy and is a petroleum-derived plastic containing bisphenol A, better known as BPA, an industrial chemical compound that protects food, but at the same time releases particles that interfere with human health. "BPA is similar to estrogens, that is, it passes into food as an endocrine disruptor, just as hormones do, and is associated with the appearance of diseases such as cancer and diabetes, as well as growth problems in infants and adolescents," Heredia points out.

Therefore, the use of BPA for the manufacture of food packaging such as food and beverage cans is banned in Spain by the Law on Waste and Contaminated Soils for a Circular Economy of 2022.

In a search to find a solution, the researchers have reused the by-products obtained after processing tomatoes to make gazpachos, sauces or juices, which are made up of seeds, skins and small stalks. Today, tomato pomace is disposed of as solid waste, which is burned or, to a small extent, used in animal feed due to its low nutritional value.

In the study, titled "Bio-based lacquers from industrially processed tomato pomace for sustainable metal food packaging" published in the *Journal of Cleaner Production*, experts propose a biodegradable alternative for coating food packaging based on the circular bioeconomy of a product such as tomato.

Among its main characteristics, this biological and environmentally friendly resin derived from tomato processing residue repels water, adheres firmly to the metal of the can coated with it and has anti-corrosive properties against salt and any liquid. After tests with simulated food, the next step will be to test its effectiveness on cans and packaging containing real food and evaluate its industrial application.

The aim is to reuse a waste product, i.e., the pomace of this fruit, as raw material for other products, in this case cans and other food containers. "From a waste product we obtain an ecological and sustainable raw material that has a very low environmental impact, as it reduces the generation of waste and, at the same time, minimizes the extraction of fossil resources for the manufacture of these very containers," as was explained to Fundación Descubre by Alejandro Heredia, researcher at the Instituto de Hortofruticultura Subtropical y Mediterránea La Mayora.

Hydrophobic, adherent and anti-corrosive lacquer

To obtain this resin, the experts let the tomato pomace samples dry and subjected them to a hydrolysis process, that is, they removed any remaining water to keep the lipids, in this case vegetable fat.

Once the fat was extracted, they mixed it with a minimal proportion of ethanol, an organic compound known as ethyl alcohol. "We dispersed the sample in about 80% water and 20% ethanol. Then, that dispersion of grease in water is sprayed directly onto the metal surface to be protected. This allows it to permeate the metal, stick to the can shape and resist subsequent cuts in the container," the head of the study explains.

To achieve the binding of the molecules in the mixture and obtain the resin, the experts applied heat. "We subjected the lacquer to a temperature of 200 degrees for a very short period of time, between 10 and 60 minutes, and thus obtained the resin," Heredia explains.

Finally, the experts found that tomato pomace resin is hydrophobic, i.e., it repels water. In addition, it has a high adhesion rate to the metal of the can it coats. "If the container falls, suffers blows or receives an impact during its transport, for example in a delivery truck, the resin acts as a protective barrier between food and metal," says the researcher from La Mayora.

In addition to these qualities, this resin also has a high anti-corrosive capacity against salt and any liquid. "The compounds of this lacquer do not pass into the food and, therefore, do not contaminate the product contained in the can, as is the case with BPA resin," Heredia explains.

Tests with simulated food

To confirm all these properties, the experts carried out tests with food simulants, as established by the European Union regulations for plastics

that are in contact with food. "We use products that mimic the behavior of a group of foods with similar characteristics. For example, we use ethanol solutions as if they were soups, oils as if they were creams and absorbent polymers as if they were dry food," Heredia specifies.

In addition to identifying the characteristics of tomato pomace resin as a coating for the inside of the containers, experts have evaluated the environmental impact of the manufacture of this resin.

To this end, they have analyzed the entire manufacturing process, from the extraction of the raw material to the production of the lacquer and its final use. They have also compared these results with the equivalent process when using BPA resin, and what happens if tomato pomace is eliminated by burning it directly in the industry. "This analysis reveals that obtaining tomato pomace resin produces less carbon dioxide than BPA resin. And when not using the tomato pomace but burning it instead to get rid of it, the pollution it produces is also greater than its reuse as a resin," Heredia points out.

At the same time, they have also identified and quantified the effects on human health caused by the production of this resin. "The impact levels are low compared to the effects of the use of BPA in everyday products," warns the researcher.

After carrying out tests with food simulants, the next step will be to test the behavior of the resin with real food. "We would take tomato sauce, tuna, and other foods that are usually sold in cans, and we would sterilize them, put them in tins and check if they withstand real conditions," Heredia explains.

More information: José J. Benítez et al, Bio-based lacquers from industrially processed tomato pomace for sustainable metal food packaging, *Journal of Cleaner Production* (2022). DOI:

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