Can I eat some water, please ?

Common plastic bottles roughly take 500 - 1000 years to degrade. Obviously, there is a complete mismatch between how long they are used for and how long the environment takes to decompose them. Transparent plastic bottles made from polyethylene terephthalate (PET) are recycled into new bottles, plastic containers for fruits and vegetables, textile fibres, carpets and stuffing for mattresses, jackets and sleeping bags [https://www.fostplus.be/en][1]. However, tons of empty bottles are dumped every year all over the country and many of them ultimately end up in the ocean where their disappearance is much slower than the supply of new ones. The giant accumulation of plastic called the Great Pacific Garbage Patch contains at least 79000 tons of discarded plastic, covering an area of ~1.6 million square km [https://abcnews.go.com/]. Of course, there is more than water bottles in the garbage patch, but they have much to account for. And when the fossil fuel and energy required to produce plastic bottles are factored in, it becomes clear that a sustainable solution is needed to stop, or at least significantly reduce, the damage to our environment. I am simply referring to what is floating around in the ocean without even speaking about tidying up the mess. Has a sustainable and satisfactory solution already been found? What about edible packaging?

"… I've slurped water. I've guzzled it. I've sipped it. But I've never eaten it. That changed when I tried my first Ooho. Ooho – or edible water – is the brainchild of Pierre Paslier and Rodrigo Garcia Gonzalez, who wanted to create an alternative to plastic bottles, the ones many of us buy every day and toss away. Their ingenious solution is an edible, seaweed-based membrane that holds water…"

This was the introduction of a striking article published by Julia Platt Leonard on April 17, 2017. Ooho is a blob-like, edible water capsule that stores a big sip of water within a biodegradable, tasteless membrane chiefly made from calcium chloride and a seaweed derivative called sodium alginate [http://www.oohowater.com/]. Alginate is a biomaterial that has numerous applications in biomedical science and engineering because of favourable highly desirable properties including biocompatibility and ease of gelation. To date, alginate hydrogels are particularly attractive in wound healing, drug delivery, and tissue engineering applications [Lee & Mooney 2012].

The water inside the membrane quenches the thirst; the membrane itself can either be swallowed or spat out. It will hardly cause any unwanted effects: it is both easily digestible and biodegradable. The inventors believe that Ooho can be the global solution to water and other "on-the-go" drinks. Much less energy (and much less CO_2 emission) is required to produce Ooho compared with PET bottles. That makes it a far more sustainable alternative to synthetic plastic bottles. Oohos are also much cheaper to manufacture compared to plastic bottles. Also, their green credentials are likely to resonate with sustainability-conscious audiences.

Paslier and Gonzalez found inspiration in a very unusual place. Their exploration began by looking at fake caviar. Oh, yes, caviar is supposed to be a delicacy of salt-cured roe from wild sturgeons. Some

[1] Fost Plus is responsible for promoting, coordinating and financing the selective collecting, sorting and recycling of household packaging waste in Belgium. On its website the cooperation claims it recycles ~680000 tonnes of packaging, or almost 90% of all packaging that finds its way onto the Belgian market.

people will do anything for a quick profit however including producing and selling fake caviar. Fraudsters replace the real delicacy with small fish balls basically made of alginate, which is an extract from brown seaweed. Simply google “fake caviar” and you will find how to make small caviar-like balls. This of course is not meant as an invitation to set up a fake seafood business!

Drinks in edible, easily digestible membranes: it sounds futuristic, but it is not. Edible packagings and coatings are time-honoured practices. As early as the twelfth century, citrus fruits from Southern China were preserved for the Emperor’s table by placing them in boxes, pouring molten wax over them, and sending them by caravan to the North [Hardenburg 1967, Pavlath & Orts 2009] . While their quality would not have been acceptable to our modern society, the method was quite effective for its time and was used for centuries for lack of more efficient solutions.

Another example with a long history also has its roots in Asia: yuba, a very famous delicacy in some places. Soybeans are somehow connected to most Japanese delicacies, including the versatile and nutritious tofu skin, known as yuba in Japan. Yuba is the by-product of boiled soy milk. Just like the natural process we all have observed when heating cow’s milk, a film (yuba) forms on the surface of boiling soy milk. While most people will discard the “icky” skins from cow’s milk, the Japanese keep the yuba. They love it mainly because of its nutritional value: it contains ~55 % protein and ~25 % vegetable oil on a dry weight basis, and it is low in cholesterol [Shurtleff & Aoyagi 2012]. But yuba has also a delicate form and an easily adaptable natural flavor. Japanese people eat it from breakfast to dessert. Yuba films have been traditionally utilized for wrapping meats and/or vegetables. The good oxygen barrier capacity of soy protein isolate (SPI) films can be utilized in the manufacture of multilayer packaging, with the protein films functioning as the oxygen barrier part. SPI coatings on pre-cooked meat products offer good protection against lipid oxidation as well as moisture loss. Moreover, incorporation of additives such as antioxidants, flavouring agents, etc. can improve the overall quality of the packed food products [Buffo & Han 2005]. Also, SPI films may find applications such as micro-encapsulating agents of flavours and pharmaceuticals or in coatings of fruits, vegetables and cheese [Petersen et al. 1999]. And SPI coatings can be used on certain food products such as meat pies and cakes, which require films that are highly permeable to water vapour [Gennadios et al. 1993].

These are but a few examples of the wide range of applications. Often, we are so familiar with edible films and coatings that we do no longer think about them. Did you notice that the fruits in the bowl were treated? Did you think about the coating when you bit into the apple you were eating?

Some 25 years ago, the use of edible films and coatings as carriers of active substances was already suggested as a promising application of food packaging [Cuq et al. 1995]. They are now commonly used.

Edible packaging is not completely without its critics. Some people feel that the edible nature of the packaging defeats its main objective, which is to protect the food from dirt, chemical contaminants and germs and to improve its shelf life. And there is a psychological barrier that people need to overcome when ingesting soluble polymers (or in other words “soluble plastic”), even when they are biopolymers and were given a special flavour.

The Ooho company wants to gain its place on the market as an alternative for single-serve water bottles, generally bought in food and drink outlets. Moreover, large-scale outdoor events such as festivals, major sporting events, etc. might also be an access route to the market. But then, is water really the number one drink at the big festivals?

There are however quite significant challenges that the company must overcome before it can diffuse into the mass market. While Ooho capsules are suitable in single-serve settings, their practicality outside this particular area appears to be somewhat questionable. Unlike bottles, Oohos have a short shelf life of a few days, carry a potential choking hazard and only offer single-gulp consumption. Moreover, the fragility of the product's membrane means they are less suitable for long-distance transportation and use throughout the day, or throughout a few days (at most).

Hygiene is another problem that must be addressed since, without packaging, the membrane is exposed to chemical and microbiological contamination which can be harmful when ingested. Food safety regulators will be concerned about the number of hands and surfaces food and beverages wrapped in edible packaging are likely to come in contact with on their way to a shop shelf and ultimately to the consumers. The company may need to provide Oohos with some protective packaging, which of course would go against their packaging-free mission. To decide that the edible packaging must be protected by additional packaging might become self-defeating.

Ooho is an innovative product idea and will serve as an excellent, sustainable alternative to packaged water products in single-serve, on-the-go settings, especially at mass events. Outside this channel, however, the functionality of the product becomes somewhat restricted. In all likelihood, further innovation will be required if Ooho is to replace plastic water bottles on all consumption occasions.

Is edible packaging a crazy idea or a promising development? Generally speaking, the production of edible films is still mainly at the laboratory scale. It is also considered to be expensive compared with synthetic plastic films. Research on cost reduction and production on larger scales are necessary to promote the feasibility of commercialized edible packagings. The feasibility of commercialized systems depends on the complexity of the production process, size of investment for film production or coating equipment, potential conflicts with conventional food packaging systems, and manufacturer resistance to the use of new materials [Han & Gennadios 2005].

Additionally, food manufacturer demand is for long shelf life for products in interstate as well as international commerce. Edible packaging materials are themselves inherently susceptible to biodegradation, and their protective functions are therefore stable for shorter durations than is the case for conventional packagings. The stability and safety of edible packagings under the intended storage and use conditions therefore require further investigation.

We are well on the way to developing a new packaging concept, but more progress is needed. Scientists, industrial partners and public authorities must join forces.

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