

# Review of innovations in the use of edible containers and cutlery

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## **Abstract**

The author has listed innovations in the use of edible containers and cutlery in chronological order. Also, an all-inclusive classification was developed as none was found in literature- things used to eat/drink food, edible pouches, things used as utensils and food packaged with food. Widely used processing techniques and materials to manufacture edible containers and cutlery such as mix of flours, polymer films and food composites are discussed. The paper concludes with future prospects and advantages and disadvantages, showing that while edible containers and cutlery will help to cut down plastic waste, their use must be done judiciously.

*Keywords: edible containers; edible packaging; edible cutlery; edible films*

## 1. Introduction

### 1.1. What are containers and cutlery?

Devices which can be used to store, contain and/or transport materials or objects by means of creating a partially or fully enclosed space are referred to as containers. For the purpose of this paper, containers will be regarded as devices which can store, contain and/or transport food or drink. Examples of edible containers like plates made of various edible materials, cones such as ice-cream cone, bread bowls, capsules, etc. will be taken up in the further sections.

Hand implements used in preparing, serving and especially eating food are referred to as cutlery. In this paper, cutlery which is edible has been considered. Some of the examples considered in this paper are baked spoons made of flours, 'puri(s)' served along with Bhel-puri a popular snack developed in the city of Mumbai in India.

### 1.2. What is meant by edible containers and cutlery?

Till now we were having a human centric approach towards edible cutlery and most if not all of the prior literature referring to edible containers and cutlery has focused only on containers and cutlery that can be eaten by humans. According to the author this way of not considering any possibility of containers and cutlery being edible by animals is a very narrow approach.

In this paper the author has also considered containers and cutlery which is edible by animals. The main reason for doing this was due to the fact that, just because a container or cutlery is edible by humans does not mean that humans will consume it.

This may be due to various reasons. One reason can be considered to be hygiene. Let's take the example of an edible plate. A plate is usually rested on some surface while eating. So, if the surface is not clean, humans will not eat the plate even if it were made of a material edible by humans. Palatability may be considered as another reason. Just because one person may like the taste of the edible containers and cutlery, does not mean it will be liked by all people. The people who do not like the taste will end up throwing the containers and cutlery even if it is edible. Also, even if one likes the taste of the edible containers and cutlery; whether or not a person will eat it will depend on whether the taste of edible containers and cutlery is complementary to the taste of the food being served. For example, instead of the crispy nature of the ice-cream cone if the cone was soggy and made up of a bitter tasting edible material, people would avoid eating the cone after finishing their ice-cream. Additionally, there are some cases mentioned in literature where the containers or cutlery are not edible by humans directly as they are too stiff. These have to be soaked in water or some other liquid before they can be consumed by humans. After finishing a meal, most people are unlikely to go through this exercise. Hence, even if the use of edible containers and cutlery were to become widespread; much of it is likely to be thrown by humans.

This is where animals come into the picture. The containers and cutlery, edible by humans which is thrown away can be collected and can be used as feed for herbivorous animals like cows and omnivorous animals like dogs.

So, while considering this possibility of containers and cutlery edible by humans being actually consumed by animals, the author has also additionally considered the containers and cutlery made of materials like leaves which is inedible by humans but edible by animals.

### 1.3. Benefits due to edible containers and cutlery

Containers and cutlery are widely used in our daily lives. Usually, they are made of materials such as stainless steel, aluminum, steel, iron, copper, brass and other alloys. These are usually reused after cleaning. But, along with these materials often plastic containers and cutlery are also used. These are often thrown away after a single use and therein lies the problem<sup>9</sup>.

These plastic containers and cutlery which are usually non-biodegradable get accumulated in the environment. To put the amount of waste in perspective, it is estimated that Indians use about 120 billion pieces of plastic cutlery per year. This number is about 40 billion in the United States. In case of plastic cutlery, people usually avoid recycling as they are considered to be too small, too lightweight and too contaminated. To counter this there are already campaigns like encouraging people to say no to plastic cutlery when taking food delivery. Also, many governments are banning the use of single-use plastic<sup>17,29</sup>. Along with these initiatives if we shift to edible containers and cutlery the production of plastic waste will be reduced.

Also, there are some health benefits associated with edible containers and cutlery. In case of leaves being used to make containers, in many cases these leaves have various health enriching substances such as antioxidants and alkaloids. These get leached into the food when it is placed on the leaf and get consumed along with the food we eat. These chemicals are supposed to lower risk for even serious diseases such as cancer and diabetes<sup>25</sup>. Also, in case of edible cutlery made up of flours; flours can be chosen such that they are made up of cereals which are very healthy but are not consumed normally. For example, the edible spoons sold by Bakely contain Jowar as an ingredient along with Rice and Wheat flour. According to the creator of this spoon Narayan Peesapaty, he decided to include Jowar as it's a nutritious grain with multiple health benefits<sup>32</sup>.

## 2. History of edible containers and cutlery

Edible containers and cutlery are being used since the ancient times. It is just that earlier the materials and methods to produce the edible cutlery were not scientific and technical. They were mainly based on logic and common sense. It is only in the recent times, that people are looking at edible containers and cutlery scientifically by considering novel materials and newly developed processing techniques. Also, inventors are now paying attention to sustainability. They have started considering things like whether the particular raw material being used to make the containers and cutlery is available locally or not and whether it is renewable.

The earliest possible example of edible containers and cutlery may have been the use of leaves as containers to store food in or as a plate. Possibly from the prehistoric times itself, humans may be using leaves for this purpose. Actually, even now Banana Leaves are used instead of plates in many places. Also leaves are regularly used to wrap up articles for sale in many countries. For example, berries are sold in a

cone made of a leaf in many places in India. This use of leaves as a container should be encouraged because such a packing is readily edible by animals and is biodegradable too.

From these leaf plates which usually consisted of a single large leaf, humans soon advanced to stitching leaves together to make stronger containers and obtain a proper plate like structure. A variety of leaves can be used for this purpose. In fact, in case of India, such plates have been used traditionally. Also, even now such plates are often used. In the Indian states of Chhattisgarh, Andhra Pradesh, Telangana, Madhya Pradesh and Odisha, tribal people practice leaf stitching to make leaf plates as a source of livelihood. These plates are extensively used for occasions such as religious functions, marriages and festivals. Also leaves have been used as material for food packaging in India<sup>19</sup>.

Leaf plates called as Patravali, Pattal, Khali, Vistar or Vistaraku are examples of such leaf plates. They are usually made of Sal, Banyan, Pala or Jackfruit leaves stitched together using tiny wooden sticks<sup>4</sup>.

A snack named Panipuri, Golgappa or Fuchka is mentioned in the Indian Epic 'Mahabharata'. For making this dish potato mash, onion, chickpeas, tamarind chutney, chili powder, chaat masala, flavored water, etc. is put in a round or ball shaped hollow deep-fried crisp crepe called puri. So, the puri can be considered as an edible container for the food put inside. These puris are usually made of semolina<sup>24</sup>. This puri is possibly the first known example of edible containers and cutlery that could be consumed by humans.

The next innovation can be considered to be the Bread Bowl first made in 1400s. In 1427, an Irish nobleman came up with the first bread bowl to impress a British Duke. It is said that the duke was so impressed by this innovation that he helped the Irish nobleman to set up a shop selling Bread Bowls in Dublin<sup>12</sup>.

Later in the 18th Century, canapés were developed in France. They consisted of some savory food being put on a small bite size piece of cracker, puffed pastry or bread which was sometimes toasted. This snack was supposed to be eaten often in one bite and was supposed to be held in the fingers<sup>2</sup>. The piece of cracker, puffed pastry or bread can be regarded as an edible container.

Medicine Capsules can be considered as the next innovation related to edible containers and cutlery, considering them as edible containers for medicines. Medicine capsules are of two types- soft capsules which consist of single-piece gel encapsulation and hard capsules which consist of two-piece gel encapsulation. The soft capsules were developed first. Mothes and Dublanc were granted a patent for a method to obtain a single-piece gelatin capsule that was sealed with a drop of gelatin solution in 1833. Later in 1847, James Murdoch patented the two-piece telescoping gelatin capsule<sup>28</sup>.

In 1896 the iconic ice-cream cone was first produced in New York by Italo Marchiony who had emigrated from Italy in the late 1800s. He was granted the patent for his invention in 1903. Also, a similar creation was made by Ernest Hamwi, a Syrian concessionaire independently at the 1904 St. Louis World's Fair. When an ice-cream vendor in a booth next to him ran out of dishes to serve ice-cream, Hamwi who was selling a crisp, waffle-like pastry called zalabis hit upon an idea. He rolled his waffles into cones and gave them to the ice-cream vendor. The ice-cream vendor then put his ice-

cream into the cones and sold them to his customers who liked the creation<sup>16</sup>. But even before this from as early as 1825, edible cones have been mentioned in French cooking books where Archambault<sup>1</sup> talks about how one could roll a cone from little waffles.

Another example of using an edible container for ice-cream is Ice-cream Sandwich. It is believed to be invented in 1899 by a pushcart salesman in New York. Here ice-cream is sandwiched between two biscuits, cookies, etc. These biscuits and cookies can be regarded as a form of edible container.

Later in 1930s, Tosada bowl was developed to make use of stale tortilla. Several variations of this bowl are used extensively today. Later in 1980s Sourdough boule bowl was developed. Its popularity resulted as a result of using these edible bowls as a marketing gimmick to market clam chowder, a type of soup<sup>12</sup>.

Around this time a snack named Bhel-puri was developed in the city of Mumbai (then known as Bombay) in India. Bhel-puri is a savory snack made of puffed rice, vegetables and a tangy tamarind sauce. The puri(s) made of refined wheat flour are crisp and round in shape. They are usually served with Bhel-puri and are used like a spoon to eat the snack. So, we can consider the puri as an example of edible cutlery.

Around mid-1970s, a company selling sweets called Barratt came up with a product called Sherbet Dip Dabs. They were basically different flavored lollipops that came with sherbet powder. These lollipops were to be used to shovel the sherbet power into your mouth and later they themselves would be consumed<sup>27</sup>. We can consider the lollipop to be a sort of an edible spoon here.

Many more of such examples are present. People have used cabbage leaves as spoons, sharpened carrot sticks to use as skewers, molded chocolate in shape of spoons and bowls, used buns as containers for burger patty, used lettuce leaves as wraps, etc. The purpose of illustrating these examples was to emphasize upon the point that the concept of edible containers is not something new. It is something that has existed for a long time.

The edible containers and cutlery discussed till now can be considered as having been produced using methods that were not scientific and technical. But since the 1980s, many people are using a scientific approach to produce edible containers and cutlery. The innovations which have used a scientific approach have been described in detail in the sections ahead.

### 3. Market study of edible containers and cutlery

Edible containers and cutlery market is currently experiencing phenomenal growth due to the rising awareness of the environmental problems associated with plastics due to their non-biodegradable nature.

This can be seen by reports compiled by various market research firms<sup>31,35</sup>. In 2019, global edible containers and cutlery market was reported to be \$27.2 million. This is expected to increase to \$56.9 million by 2026 with continuous annual growth rate of 11.1%. Major factors for this growth are increasing use of edible containers and cutlery while serving food by various airlines and multiple sops offered by various governments across the world in the hope of reducing carbon footprints. In 2019, edible spoons were reported to have a major market share of edible containers

and cutlery and they constituted about one-third of the market. Geographically, North America was reported to have the highest market share cornering two-fifth of the market in 2019. But the Asia Pacific region is expected to show the highest continuous annual growth rate of 12.7%.

There are a large number of companies selling edible containers and cutlery; and competition between them is intense. So, they are trying to use strategies like constantly innovating new flavors and increasing production capacities to stay relevant.

Some of the major companies producing edible containers and cutlery are-

- Edibles by Jack, a company from United States whose main product is edible spoons.
- Biotrem, a Polish company producing tableware such as bowls and plates made of wheat barn.
- Mede Cutlery Company, a Chinese cutlery company with one of their product lines being edible tableware.
- Candy Cutlery, a Canadian company producing various types of edible containers and cutlery such as spoons and shot glasses.
- UniCrave Technologies and Unreasonable Group are also major players.

#### 4. Types of edible containers and cutlery

Given below is a classification of edible containers and cutlery made by the author after doing extensive literature survey. Many other classifications are reported in literature, but they consider either only edible cutlery or only edible containers. A combined classification was not found by the author. Some innovative examples from each category are mentioned.

##### 4.1. Things used to eat/drink food

Edible cutlery such as spoons, forks, knives, straws, chopsticks and tongs can be considered as a part of this category. These are usually made by baking various flours taken in proper proportion.

In 2011, Narayana Peesapathy an Indian groundwater researcher turned entrepreneur started Bakeys Food Pvt. Ltd. to produce edible cutlery. This is considered by many to be the first commercial instance of scientifically developed edible cutlery. Peesapathy is supposed to have thought of making edible cutlery after watching a family eating lunch using a piece of Khakhra (a type of cracker eaten in India). Edible cutlery of various flavors is made from flours of various grains such as rice, sorghum (jowar) and wheat and commonly available spices. Their products do not become soggy immediately after coming in contact with water. Rather after 10-15 min they just soften. So, at the end of the meal, they can be consumed easily.

Peesapathy with his knowledge of crops as a groundwater researcher, wants to promote jowar as an alternative for rice. This is because jowar requires only quarter amount of water of that required for cultivation of rice<sup>30</sup>.

Kong<sup>18</sup> has described different formulas for making edible cutlery in different parts of the globe, considering the most common grains in each area. For example, he has recommended majorly using rice and soyabean in Asia; wheat, corn and soyabean in the United States; rice and tapioca in Southeast Asia, etc. This ensures that ingredients

need not be transported from far distances and the carbon footprint of his edible cutlery reduces.

Nounes et al.<sup>21</sup> have developed edible cutlery made of the same ingredients as pasta i.e., wheat, semolina and water. They have talked about several variants of their cutlery such as plain, sweet and flavored.

##### 4.2. Edible pouches

Edible pouches for water or groceries can be considered in this category. Capsules containing medicines and condiments may be considered as a part of this category too. These are basically edible containers. These are made of edible films usually.

One of the widely known product from this category is the edible water pods called Ooho developed by United Kingdom based Skipping Rocks Lab. They were distributed during the 2019 London Marathon and gained wide-spread publicity. They are manufactured from seaweed entirely with a shelf life of a few days to ensure that the water inside remains fresh. Ooho pods are also being tested as a container for ketchup in fast food restaurants. The pod could be flavored or colored to make it more palatable<sup>8</sup>.

Other examples of innovative products from this category are a series of packaging pouch like containers developed by Swedish company, Tomorrow Machine. They have developed a pouch made of caramelized sugar coated with wax containing oil which can be cracked open when oil is needed. A pouch made of agar has been developed to contain a smoothie. Also, pouches made of bee wax have been developed as containers for grains and flours. All of these types of packaging are edible and are meant to be eaten. But even if they are thrown away, they bio-degrade quickly<sup>33</sup>.

Monosol, is another company that has developed edible pouches to contain food. Their pouches have no inherent smell or taste and dissolve completely in both hot and cold water. Monosol is marketing these pouches as containers of ready to eat food and pre-measured ingredients. These pouches are intended to be put in water directly and are to be consumed with food contained inside<sup>33</sup>.

Eco-bags developed by Avani, an Indonesian sustainable disposables company can be considered in this category too. These bags are made from natural resins such as cassava root starch. This is edible by humans only after dissolving in water, but land and marine animals can eat it directly<sup>34</sup>.

Yuasa<sup>36</sup> has developed a food encapsulated capsules which can be made of pullulan, gelatin or hydroxypropyl methylcellulose which dissolve in contact with water. According to Yuasa, we could store seasonings like spices, beverage powders like coffee power or oil inside the developed hard capsules. And when these are needed, these capsules could simply be put in food wherein they would dissolve and release the contents stored inside.

Ghosh et al.<sup>14</sup> have described use of films made of semi refined kappa carrageenan to make pouches to store oil. Additionally, many researchers such as Farhan et al.<sup>11</sup> have described how semi refined kappa carrageenan has high potential to be used to make edible film.

##### 4.3. Things used as utensils

Edible containers such as plates, bowls, cups, glasses and cones can be considered as a part of this category. These too are usually made by baking various flours taken in proper

proportion. But in some cases, ingredients like cane sugar are used. Sometimes, plates and bowls can be made of leaves too.

Loliware, a start-up from United States has developed a line of cups made of agar along with ingredients such as sugar, tapioca starch, vegan gelatin and natural flavors. These look like glass but taste like flavored Jell-O or candy<sup>3,33</sup>.

In 2015 KFC (Kentucky Fried Chicken), also came up with an edible coffee cup made of cookie and white chocolate and wrapped in sugar paper<sup>33</sup>.

#### 4.4. Food packaged with food

This category can be considered to contain things like burgers wrapped in edible wraps, ice-cream sandwich due to the two biscuits acting as containers, burger buns acting as containers for burger patty, etc. In this case, the food packaging can be naturally available as in lettuce wrap, can be something common like a biscuit or bread or can be something complex such as a specialized edible film.

An example of a commercially available innovative product in this category is WikiPearls developed jointly by Stonyfield Farm, Inc. and WikiFoods. WikiPearls consist of a single serve spheres containing frozen yogurt center encased within an edible gel skin. The gel skin is made using algae and calcium. It can be flavored to complement the product contained. It does not melt and the skin can be washed before eating just like any common fruit. While eating consumers can eat the WikiPearls whole or they can peel away the skin and consume only the yogurt inside like a normal fruit. The environmental advantage of this type of gel skin is that even if it is thrown away it biodegrades quickly<sup>33</sup>.

Another example is a wrap made of potato starch served by an ice cream truck company in United States called Coolhaus along with ice-cream sandwiches. These edible wraps are supposed to serve as both wrapper of the ice-cream sandwich and as a napkin. Many other companies are following this idea.

Also, many burger chains are selling burgers wrapped in edible papers. This leads to less messy eating as customers don't have to unwrap the burger. Also, the paper can serve as a napkin thus reducing paper waste. A Brazilian fast-food chain called Bob's was one of the first to try this idea<sup>33</sup>.

Dellinger et al.<sup>6</sup> have developed an edible container specifically for pets in the shape of bones, fish, etc. so that it will be attractive to the animals. Pet food can be put in these containers, later the pet can eat this container along with its food. This container is made using mainly starch, natural fibers and water. Basically, this container is an edible composite with starch as the matrix.

Sun et al. (1999) have also developed an edible composite to make feed packaging containers for animals. But their main target is livestock specifically. Starch and protein rich flour are used as matrix. Fibers derived from straw, corn stalks, sorghum stalks, soybean hulls and peanut hulls are used to make their composite.

## 5. Materials used for producing edible containers and cutlery

After doing literature survey, the author realized that a wide variety of materials are used to make edible containers and cutlery. Here the author has tried to highlight upon the materials encountered in the earlier sections.

### 5.1. Mix of flours

Most of the edible containers and cutlery consists of a mix of flours. Flour is basically a powder obtained by grinding raw grains, seeds, beans, nuts, roots, etc. A variety of flours such as jowar flour, rice flour, wheat flour, corn flour, soyabean flour, potato flour, tapioca flour, peanut flour, flaxseed flour, oat flour and barley flour can be used to make edible containers and cutlery<sup>9,18,30</sup>.

A common thing among all these flours is that they have high starch content. This is what makes them good ingredients for edible containers and cutlery.

Starch is made up of two kinds of molecules, amylose (normally 20-30%) and amylopectin (normally 70-80%). The amylose part is responsible for the flexibility of starch. This is due to the  $\alpha$ -1-4 glycosidic bonds of amylose chains which give flexible random coil conformation to the molecule. This is especially useful in case of edible films made of starchy substances<sup>26</sup>.

### 5.2. Polymer films

Edible polymers are typically divided into four categories-hydrocolloids, lipids, polypeptides and composite polymers<sup>26</sup>.

Hydrocolloids are a group of long chain polymers that form gels when dispersed with water. Due to large number of hydroxy (-OH) groups present in them, they have an affinity to bind to water molecules. So, they are considered as hydrophilic compounds. However, they don't dissolve in water. Rather they produce a dispersion and exhibit properties of a colloid. So, they are aptly termed as hydrocolloids i.e., hydrophilic colloids<sup>22</sup>.

Agar<sup>3,33</sup>, alginate<sup>10,33</sup>, starch<sup>9,18,30,34</sup>, hydroxypropyl methylcellulose<sup>36</sup>, carrageenan<sup>3,11,14</sup> and pullulan<sup>36</sup>, pectin<sup>3</sup> encountered in the previous sections are all hydrocolloids.

Lipids used in polymer films are natural waxes, acetylated monoglycerides and surfactants. Bee wax<sup>33</sup> encountered in the previous sections is a commonly used lipid to make polymer films<sup>26</sup>. Bee wax is a mixture of several chemical compounds. Linear wax monoesters and hydroxy monoesters predominantly of chain length of C40-C48 constitute 35%-45%, complex wax esters constitute 15%-27%, hydrocarbons predominantly of chain length of C27-C33 constitute 12-16%, free fatty acids with chain length of C24-C32 constitute 12%-14% and free fatty alcohols of chain length of C28-C35 constitute around 1% of bee wax<sup>13</sup>.

Polypeptides consist of protein based edible polymers. Gelatin<sup>33,36</sup> encountered in the previous sections is a type of polypeptide.

### 5.3. Food composites

This is an emerging area on which a lot of research is being done as composite materials have the promise of giving high strength and greater durability to edible containers and cutlery made from them.

Researchers are trying to make reinforced composites typically using starch or polypeptides as the matrix, while fibers are being derived from multiple sources like straw, corn stalks, sorghum stalks, soybean hulls and peanut hulls in case of Sun et al. (1999).

Researchers are also trying to make composite polymers consisting of layers of different polymers trying to combine the good qualities of each of the polymers used<sup>26</sup>.



## 6. Processing techniques used for producing edible containers and cutlery

After doing literature survey, the author realized that edible containers and cutlery are manufactured in a variety of ways. Here the author has tried to highlight upon some of the most widely used techniques used to manufacture edible containers and cutlery today.

While a lot of traditional techniques are available too such as stitching of leaves mentioned in the section “History of Edible Containers and Cutlery”; the author has chosen to highlight only some modern methods here.

### 6.1. Method to manufacture edible containers and cutlery made of mix of flours

Most of the edible containers and cutlery consists of a mix of flours that is knead and then baked into desired shape. Most types of edible spoons, forks, knives, plates, bowls, chopsticks, tongs, cups and cones are manufactured by this method.

The steps are as follows<sup>9</sup> -

- Mixing one or more carbohydrate rich starch with some liquid like water to gelatinize the inherent starch.
- Adding some lubricating agent to the dough.
- Making sheets out of the dough.
- Forming the dough in required shape making use of molds.
- Baking the formed shapes. This is usually done at 150°C to 400°C for 3 to 15 minutes.
- Obtain the desired edible container and cutlery.

To form the containers and cutlery compression molding is mostly used.

Compression molding is a type of forming where a plastic material is placed into a heated mold. This plastic material gets softened by heat and it is forced to conform with the shape of the mold as it closes.

The process is as follows<sup>7</sup> -

- Place the material to be molded in an open mold cavity (female mold). Generally, the material to be molded is preheated to gain plasticity.
- Thereafter, the mold is closed by applying pressure from the top (male mold pushed into the female mold). This applied pressure ensures that the material to be molded comes in contact with all mold areas i.e., fills up the cavity between the male and female mold.
- Then the male and female molds are locked in the mating relationship to avoid displacement of the molds as the dough is getting cured (baked).
- Simultaneously heat is applied which leads to curing (baking) of the containers and cutlery.
- After some pre-decided time, the heat and pressure are relieved and newly baked edible container and cutlery is obtained.

Methods to manufacture edible containers and cutlery developed by Seto<sup>23</sup>, Huxel et al.<sup>15</sup> and Dembecki<sup>7</sup> use this method of compression molding.

### 6.2. Method to manufacture edible shells for liquid encapsulation

This is the method used to obtain WikiPearls described in the section “Types of Edible Containers and Cutlery”<sup>10</sup>.

The process is as follows-

- The liquid to be encapsulated is frozen in the desired shape.
- Then the solid form of the liquid is further cooled in liquid nitrogen. This is done as after experimentation, Edwards et al. realized that liquid nitrogen produces a dried and cold surface which is advantageous for the next step.
- Thereafter this liquid nitrogen cooled solid form is dipped in the solution of the substance of which you want to form the edible film. Alginate was used in this case. Upon contact with the cold surface, alginate freezes forming a layer. The thickness of this layer can be controlled by changing the residence time of frozen solid in alginate solution.
- In case a thicker and more rigid film is required, this step could even be repeated.
- Thereafter, the film covered frozen solid is washed by rinsing and the liquid within the film is allowed to melt gradually. Water was used for rinsing in this case.

### 6.3. Using 3-D printing to create edible containers and cutlery

This is an emerging area. Many researchers such as Contractor et al.<sup>5</sup> and Langeland<sup>20</sup> have developed 3-D printing technology to print edible objects in desired size and shapes. This technology could be used to manufacture edible containers and cutlery too.

## 7. Conclusion

Edible containers and cutlery are being widely used across the globe and their popularity is rising rapidly. This can be seen from the large number of companies manufacturing these and the constantly increasing number of innovative products available in the market.

Undoubtedly edible containers and cutlery help in the reduction of plastic waste. But, something to think about is whether edible containers and cutlery are more environmental friendly than reusable containers and cutlery. Edible containers and cutlery often come in plastic packaging. Also, a lot of processing steps and transportation is involved to make edible containers and cutlery which are then used up (eaten or thrown) in one go. Considering this, it is obvious that while edible containers and cutlery are definitely better than single use plastics; as far as possible we must stick with reusable containers and cutlery. Edible containers and cutlery should only be used where use of single use containers and cutlery is required for some reason. For example, due to logistic reasons in cases like while travelling in airlines, trains or buses. Also, in case of edible wrap for food-stuffs, we can consume the food-stuff without unwrapping leading to less messy eating and more convenience. In such cases edible containers and cutlery could be used. But they should be avoided for day-to-day use.

A thing to be considered when we talk about edible containers and cutlery is food allergies. A person who is allergic to some food-stuff, may get an allergic reaction if he eats on or consumes edible containers and cutlery containing that specific food-stuff. So, allergy advice must be explicitly mentioned on the packaging like other food products. Several companies are already working in this area. An example is manufacturing gluten free containers and cutlery to cater to people allergic to gluten.

Another thing to be considered is, what amount of edible cutlery is edible. Guidelines must be also be formed and issued with the packaging in case some of the ingredients of the edible containers and cutlery are to be consumed only in small proportions by a particular group of people. For example, consumption of edible containers and cutlery containing sugar by diabetic people should be limited.

Just like people are comfortable with simply washing fruits before eating them, peoples' approach to edible containers and cutlery must be changed. This will surely happen slowly and steadily. Maybe just like people pick fruits kept in open without packaging in supermarkets today; in the future, people could pick edible pods of food. These could be washed once before using, eliminating the need for external packaging in case of products not affected by one wash with water.

We should try to ensure that no one leaves edible containers and cutlery uneaten. This is because, if these edible containers and cutlery are just going to be thrown away, using biodegradable or compostable containers and cutlery which require less processing steps are better.

Another alternative in case people want to throw away edible containers and cutlery after having used them due to palatability or hygiene issues is containers and cutlery readily edible by animals but not so by humans. This could be due to a variety of reasons such as hardness and resistance to become soggy with water. While these are desirable properties for utility of containers and cutlery, these may make them undesirable for humans to consume.

The author found limited examples of containers and cutlery readily edible by animals but not so by humans. Some examples of edible containers which could be consumed by animals along with feed were found. But, examples of containers and cutlery to be used by humans but not eaten by them were not forthcoming. This shows that more research must be done in this area. Also, once such containers and cutlery are developed; logistics of transportation these used containers and cutlery to animal farms will have to be taken care of.

3-D printing of edible containers and cutlery is an emerging method. We could use this to manufacture containers and cutlery of any of size and shape according to requirement. Addition of antimicrobial agents to edible containers and cutlery to take care of hygiene concerns could be a promising field of research. Use of innovative edible composites materials to make strong and durable edible containers and cutlery is another promising field of research. Possibly all three research areas could even be combined to obtain antimicrobial and durable containers and cutlery of any size and shape according to requirement.

An aspect not focused upon by the author is the price of edible containers and cutlery. In most cases, its present cost is more than the plastic alternatives. Through the use of large-scale production and use of cost-effective materials and processing techniques this cost must be brought down before doors can be opened for large scale implementation.

That said, edible containers and cutlery are here to stay with us and they will indeed help in reducing plastic waste. But their use must be done judiciously.

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