Disruptive Technology Trends
Packaging Sector

January 08, 2021
### Top 10 Technology Disruptive Trends in Packaging Domain

IEBS has identified the top 10 disruptive technology trends in the packaging sector for 2021.

<table>
<thead>
<tr>
<th>Trend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled Packaging</td>
<td>Recycling has been in the industry for decades. However, the 3 R model reduces, reuse, and recycles still a part of the sustainability movement. With over 400 organizations signing New Plastic Economic Global Commitment, companies have committed to increasing their recycling packaging by 25% by 2025.</td>
</tr>
<tr>
<td>Integration of Digital Solutions (Internet of Things/Robotics)</td>
<td>Digitalization is responsible for upgrading the packaging sector with the integration of various technologies like the internet of things (IoT), robotics automation, etc., across multiple stages, including warehouse management, manufacturing, etc. Through connectivity and digital accuracy, it can ease the burden of staff oversight and improve efficiency.</td>
</tr>
<tr>
<td>Minimalized Packaging</td>
<td>Minimal packaging is becoming increasingly popular among consumers due to growing concerns about the environment. Consumers prefer products without extra wrapping and packaging. They prefer labels with only relevant information on the product.</td>
</tr>
<tr>
<td>Biodegradable Packaging</td>
<td>Biodegradable packaging is increasingly finding adopted in various industries due to its lower environmental impact. These solutions can enable natural degradation without the need for a catalyst. Meeting requirements towards reducing waste to counter the environmental impact.</td>
</tr>
<tr>
<td>Personalized Packaging</td>
<td>Digital printing contributes to making customized packaging much more comfortable by adding personalization to the product. The personalized packaging allows individuals to identify with a brand’s product. It can prove to be an innovative way of building the brand image.</td>
</tr>
<tr>
<td>Advancement in e-commerce Packaging</td>
<td>Advancement in e-commerce packaging results from growing consumer preference towards online purchasing due to the ease and convenience it provides to its customers. It can replace the primary packaging which contributed to gage customers at retail outlets.</td>
</tr>
<tr>
<td>Smart Packaging (QR codes, RFID, sensors, etc.)</td>
<td>Smart packaging plays a significant role in improving user safety about perishable products. For example, badge technology applied to product labels helps detect a product’s CO2 level indicating the freshness of food product for its consumption.</td>
</tr>
<tr>
<td>Antimicrobial Food Packaging</td>
<td>Antimicrobial agents help improve the quality of the packaged food products and reduce the use of additives and preservatives in packaged products. Growing consumption for short shelf-life products is resulting in the growth of the antimicrobial packaging market.</td>
</tr>
<tr>
<td>3D Printing</td>
<td>3D printing, also known as additive manufacturing, is a great benefit to improve the manufacturing process by enabling the rapid prototyping of machine parts. Additive technology can help in producing robotic arms for use in the packaging process.</td>
</tr>
</tbody>
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1. Recycled Packaging

Shifting consumers focus on recycling packaging

- Recycled packaging is the most convenient way to achieve a sustainable and circular packaging system. Public authorities and consumers are focused on sustainable packaging in which they are more concentrated on recycled packaging.
- Recycling of packaging materials has seen rapid expansion over the last decades in several countries. Advances in technologies and systems for collecting, sorting, and reprocessing recyclable materials are creating new opportunities for recycling.

<table>
<thead>
<tr>
<th>Impact on Consumers</th>
<th>Packaging Players Initiatives to Promote Recycled Packaging</th>
<th>Regulations Supporting Recycled Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra Cost of Recycled Packaging</td>
<td>- 0%</td>
<td>Recycled packaging used</td>
</tr>
<tr>
<td></td>
<td>- 2.5%-5.0%</td>
<td>Consumer purchased</td>
</tr>
<tr>
<td></td>
<td>- 5.0%-10.0%</td>
<td>Buy Back Model for Support Recycled Packaging</td>
</tr>
<tr>
<td></td>
<td>- 10.0%-20.0%</td>
<td>Consumer consumed</td>
</tr>
<tr>
<td></td>
<td>- More than 20%</td>
<td>Consumer return post consumed packaging and get reward</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

- #1 - A survey conducted by Trivium Packaging in the U.S., Europe, and South America in April 2020 shows that nearly 1/3rd consumers are willing to pay extra cost for recycled packaging, indicating shifting focus consumers towards recycled packaging across the developed economies.

- #2 - For instance, buyback model promotes consumer to bring post consumed packaging to the collection point to ensure easy recycling and consumer gets rewards in return. This model is prevalent among consumers in the U.K., Norway, and Australia.

- #3 - Regulatory framework of various countries is also focused on promoting recycled packaging by banning single-use plastics, regulatory favors to recycled packaging, and other means.

- #4 - Several initiatives by packaging companies, regulatory policies, and evolving consumer preferences indicate that the recycling packaging trend is disruptive in the packaging domain.
2. Integration of Digitalized Solutions (Robotics, AI, IoT, etc.)

Digital Era Transforming the Packaging Sector

The packaging industry is undergoing a profound transformation by integrating various digital technologies like artificial intelligence (AI), the internet of things (IoT), robotics automation, etc. For instance, the interconnectedness of machinery and materials and the sharing of real-time data can drastically affect the efficiency and the evolution of the product. One of the critical potential areas in the packaging sector is warehouse management.

Impact of Digital Technologies in Warehouse Management

- **IoT in Warehouse**
  - Improved connectivity and digital accuracy
  - Ease the burden of staff oversight and improve efficiency

- **Robots in Warehouse**
  - Minimize dangerous tasks for workers
  - Reduces risk of contamination
  - Reduced cost and improved output

- **Artificial Intelligence in Warehouse Management**
  - Temperature management for sensitive products
  - Initiating lockdown in case of security risk and oversee inventory

Impact of Integration of Robotics in Packaging Sector

- **Flexibility**
  - In the case of robotics, an operator can quickly change the outline for a case or pallet with a simple click of a button, which otherwise takes longer if done manually.

- **Enhanced Productivity**
  - Reduced labor and safety cost along with the ability of a robot to perform multiple tasks in far lesser time and greater accuracy

- **Minimal Maintenance**
  - Robots are tireless and thus require minimal maintenance. It can work at high speed for 70,000 hours or more before requiring mechanical failure maintenance or chance.

Impact of Artificial Intelligence (AI) in Driving the Packaging Industry Forward

- **AI**
  - Helps in demand and consumption. For example, weather data helps in improving food supply efficiency by reducing avoidable food losses.
  - Helps in environmental footprint reduction and helps attain sustainability, a key trend in the packaging sector.
  - Integration in packaging helps in improving system efficiency by detecting 90% more defects than humans.

**Improved Efficiency**

- Reduced Footprint
- Reduced Losses

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3. Minimal Packaging

Using minimal packaging material to ensure environment safety

- **Minimal packaging** or reduction in packaging material has become progressively popular while talking about sustainable packaging, especially in the food and beverages industry.
- Many influencers in the industry have pointed to Millennials as the biggest reason for the increase in Minimalism in packaging. Millennials often choose brands that are eco-sensitive, plain-spoken, and focused on simple and natural ingredients.
- The motto of Minimalism is "omit needless things." For consumer packaging, this would entail paring down packaging materials and the visual aspects of the design.

### Impact on Environment

<table>
<thead>
<tr>
<th>Negative environmental impact</th>
<th>Minimum Material</th>
<th>Optimum Pack Design</th>
<th>Minimum Possible Environmental impact</th>
<th>Increasing Packaging Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underpackaging</td>
<td>Overpackaging</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Packaging Players Innovation

**Sidle’s X-Lite – 500 ml PET Packaging for Still Water**

- **46% less weight**
- **Energy saving up to 335,000 Wh**
- **PET resin consumption reduction up to 1,485 tonnes per year**

### Benefits of Minimal Over Traditional Packaging

- **Light weight**
- **Low Raw Material Consumption**
- **Up to 70% lesser space required**
- **Easy Disposal**

- **Heavy Weight**
- **High raw material consumption**
- **Large amount of storage space required**
- **Difficult to dispose**

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**Reducing Adhesives**

Minimal packaging allows companies to remove additional graphics colors and other packaging content, which reduces adhesives, making the recycling process more manageable, convenient, and reducing the economic burden.

**Easiness for Sorting**

Minimal packaging eliminates the label or other additional items from packaging, which helps determine the material type for both manual and automated recycling plants, saving time, effort, and energy during recycling and increasing recycling efficiency.
4. Biodegradable Packaging

Eliminating the plastic waste from the environment

- Widespread use of plastic packaging has resulted in a staggering amount of plastic waste and pollution in the human-made and natural environment. This is majorly due to the challenges associated with conventional plastic degradation. Biodegradable packaging is the most suitable way to tackle waste and pollution due to plastic packaging.
- They can be easily degraded in the environment with the action of microorganisms. Thus, they are increasingly used in the form of packaging for reducing traditional plastic consumption.

### Impact of Biodegradable Packaging on Packaging Sector

#### Impact on Industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Percent Share of Plastic Used in Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>39.90%</td>
</tr>
<tr>
<td>2017</td>
<td>39.70%</td>
</tr>
</tbody>
</table>

**Source**

- Plastic Used in Packaging

#### Barrier Property Benefits

<table>
<thead>
<tr>
<th>Material</th>
<th>WVTR Property @23°C and 85% RH (g/m² d bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE</td>
<td>0.08</td>
</tr>
<tr>
<td>LDPE</td>
<td>0.01</td>
</tr>
<tr>
<td>PLA</td>
<td>51.25</td>
</tr>
<tr>
<td>Starch</td>
<td>58.75</td>
</tr>
<tr>
<td>Cellulose</td>
<td>362.5</td>
</tr>
</tbody>
</table>

**Source**

- WVTR@23°C and 85% RH (g/m² d bar)

#### Regulations Supporting Biodegradable Packaging

**#1** - The decrease in demand for plastic packaging shows the industry’s shifting trend towards biodegradable packaging. This shift of packaging material is the result of awareness towards the sustainability of packaging material.

**#2** - The study conducted by Wageningen University and Research on water vapor transmission resistance of traditional plastic and biodegradable plastic shows the advancement of biodegradable plastic properties, which is more moisture resistant and highly useful in packaging industry specially for food & beverages and pharmaceutical industry packaging.

**#3** - Regulatory framework of the European Union, such as commitment to the circular economy, shows governing authorities' inclination towards biodegradable packaging.
5. 3D Printing

Achieving Sustainability through 3D Printing in Packaging Sector

- 3D printing technology helps companies make environment-friendly packaging as it plays a critical role in reducing plastic pollution. In this case, waste can be cleaned, dried, shredded, and extruded into a printable filament that can again be recycled into a 3D printer for a new product.
- Generating less waste is environmentally friendly as well as economical.

Impact of 3D Printing on Packaging Sector

Benefits Offered by 3D Printing Technology in Packaging Sector

- **Potential Cost Reduction**
  - 3D Printing is far more efficient at producing packages than any other current method.
  - Uses minimal material and gives greater output.
  - Cost of 3D printing may go down with growing adoption in the future.

- **Quicker Prototyping Process**
  - It makes the manufacturing process more efficient by saving on material and labor as different packaging models prepared by designers can be prototyped using 3D printer and allow designers to fine-tune and refine their packaging.

- **Easy Recycling and No Waste of Material**
  - 3D printing generates no waste.
  - Does not require separate processes for creating packaging and adding printing.
  - Experimenting with different materials like plastic, nylon, metals, wax, etc., is possible.

3D Printing Contribution towards Packaging – Use Cases

1. **3D printing helped Pepsi in developing an advanced design**
   Global brand Pepsi used 3D printing technology to create a replica of the Black Panther mask for soda cans as a promotional campaign.

2. **Heineken used 3D printing to optimize manufacturing line.**
   A well-known, brewery brand Heineken used Ultimaker’s extrusion 3D printing technology to save time and money by customizing optimized parts and tools for its production line. For example, a metal can pusher used to reject and direct bottles, a stopper tool that applies bottle labels, etc.

3D printing technology impact on packaging

- According to Packaging Digest, 3D printing packaging market is expected to make an impact of USD 550 billion each year by 2025. The potential impact of this technology is enormous, and companies are noticing it.

Adoption rate of 3D printing technology

- 66.7% of manufacturers are expected to adopt 3D printing technology in some capacity, as indicated by PwC.
- In the next three years, 24.7% of manufacturers plan to adopt 3D printing technology.

3D printing technology can include full-color text and graphics. The necessary design changes (label, shape, content, etc.) can be incorporated very quickly compared to traditional methods.
6. Personalized Packaging

Providing customized solution to customers

- Personalized packaging is custom packaging featuring the name, image, or other customer's features. Personalized packaging allows consumers, products, and companies to make their unique package versus standard packaging that is the same as any other.
- Personalized or customized packaging helps companies add a personal touch, enabling companies to connect with customers. This leads to brand loyalty and, eventually, higher revenues.

Impact of Personalized Packaging on Packaging Sector

<table>
<thead>
<tr>
<th>Role in Marketing</th>
<th>Role in Winning Customer</th>
<th>Achieving Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custom Packaging Sizes and Dimensions</td>
<td>Personalized packaging can be designed to fit any shape and shape, which regular packaging does not provide.</td>
<td>Personalized Packaging can make customers feel special by adding their details and a special message on packaging. This can be achieved by e-portals or specials orders.</td>
</tr>
<tr>
<td>Technical Details</td>
<td>Personalized packaging can help to provide technical details of product without using any additional label and adhesives.</td>
<td>Personalized Packaging can be very helpful for reuse model of business.</td>
</tr>
<tr>
<td>Brand Awareness</td>
<td>Personalized packaging helps in increasing brand awareness. Personalized packaging enables products to be eminent from other products.</td>
<td>Personalized packaging can be customized by using minimum packaging material.</td>
</tr>
</tbody>
</table>

Benefits in Multi-use Model and Subscription based Business

**Distinguished Empty Package Store**: Personalized packaging can be helpful in stand out alone in an empty package store for a multi-use model. The empty container can be sorted base on the product and easily transport to that product’s warehouse.

**Personalized packaging** can help companies separate the customized product by adding the product and consumer details on the package, increasing efficiency by reducing the time in identifying a suitable place and logistic route.

**Personalized Product According to customer**:
7. Evolution of E-commerce Packaging

Improved online purchase triggered the e-commerce packaging

• E-commerce sector was sailing on an all-time high in 2020 with the lockdowns, travel bans, and retail closure, which brought consumers online, and retailers started to follow. However, the companies were not entirely prepared to provide an excellent customer experience.

• Now, to compete in the marketplace, companies are planning to enhance the customer’s experiences for online purchases, making a subsequent positive impact on the e-commerce sector.

Impact of Growing E-commerce on Packaging Sector

E-commerce Sales Growth, by Region, 2020

<table>
<thead>
<tr>
<th>Region</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>16.5%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>19.4%</td>
</tr>
<tr>
<td>Central &amp; Eastern Europe</td>
<td>19.8%</td>
</tr>
<tr>
<td>Middle East &amp; Africa</td>
<td>18.1%</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>16.9%</td>
</tr>
<tr>
<td>Latin America</td>
<td>21.5%</td>
</tr>
<tr>
<td>Global</td>
<td>15.5%</td>
</tr>
</tbody>
</table>

Key highlights

• In Asia Pacific, Europe, and the Middle East, growth in e-commerce will be faster than in the U.S. in the first half of the decade.
• Nearly 150 million people shopped online for the first time in the pandemic, and the number of e-commerce buyers will continue to rise.
• The packaging sector has experienced positive gains with substantial growth in e-commerce sales.

Influence of E-commerce on Packaging Industry – Key Parameters

Speed & Efficiency

• Growing online sales has triggered the need to achieve higher speed for packaging and printing to ensure a quick delivery.
• With speed, quality, or packaging efficiency would be critically important for consumers to receive right condition products.

Versatility

• Extensive packaging range must be available to cope with the explosive growth in the e-commerce sector in 2020.
• Corrugated boxes availability in various sizes would be important as it offers strength, high durability, and recyclability.

Automation

• With strong growth in the e-commerce sector, those distributed to online customers had to incorporate or develop systems that use automation and machine technology.

Environment Friendly

• With growing online sales, the need for sustainable environment-friendly solutions has also seen a rise, majorly the recyclable ones.
• Companies are encouraging the optimum use of plastic, which means lesser packaging waste and thus a lesser impact on the environment.
8. Smart Packaging (QR codes, RFID, etc.)

Smart solutions changing the brand’s perception

- Smart solutions like QR codes, RFID, sensors, NFC technology, etc., are amongst the **disrupting solutions** in the packaging sector. These solutions are responsible for instilling a positive effect on brand perception by catering to a larger audience.
- Increasing use of smartphones has triggered the concept of QR codes on the packaging. Upon scanning, it gives its consumers the details on the product offerings, including its shelf life, composition, etc. Smart packaging solutions also help in preventing product piracy.

**Impact of Smart Packaging Solutions on Packaging Sector**

**Active Packaging – Provides Functionality like moisture and oxygen control – Sensor labels**

- reduces wastage
- delivers quality assurance
- builds brand share
- improves sales
- monitors components lifetime

**Intelligent Packaging – Communicating product changes and other information using QR codes, Specialist bar codes, etc.**

**Product Tracking throughout the supply chain**

- warehouse
- consumer homes
- shops

1. **Coca Cola improved its customer engagement with QR codes**

   **The Coca-Cola Company**

   With QR codes scanned, customers were able to scan the following:

   - Product’s origin
   - Content
   - Loyalty programs
   - Expiration dates/recipes/tutorials
   - Coupon discount
   - Closest point of purchase in case of repurchase

<table>
<thead>
<tr>
<th>Nutritional Information</th>
<th>Product News</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Loyalty</td>
<td>Brand Story</td>
</tr>
<tr>
<td>Video Tutorials</td>
<td>Personalized Information</td>
</tr>
</tbody>
</table>
9. Antimicrobial Food Packaging

Ensuring proper safety measures for packaged food

- Antimicrobial packaging is a type of **active packaging** that **prevents pathogenic microorganisms** on food products to remain **safe** for consumption for a long time.
- Antimicrobial packaging can be **achieved** by **coating** such **antimicrobial products** on packaging surfaces that are safe for food. The renewed **interest** in antimicrobial **packaging arises** from **consumer interest** in the quality and freshness of food.

### Impact of Antimicrobial Food Packaging on Packaging Sector

#### Driving Factors

- **Awareness of Food Waste**
  - Public Authorities and customers are now more concerned about reducing food waste; antimicrobial food packaging can increase the self-life of food by preventing microorganisms’ growth. Thus, antimicrobial food packaging can help in tackling the problem of food wastage.

- **Growing Demand of Sustainable Food**
  - Customers are now more focused on their health. That is why they seek sustainable food that must be free from chemical preservatives; antimicrobial food packaging can eliminate the use of chemicals in food and beverage for food safety, for achieving sustainable food.

#### Additional Benefits

- **Barrier Property**
  - Antimicrobial agents also have barrier properties against oxygen and moisture, which helps companies eliminate additional coating material on the packaging, thus its safe cost and time.

- **Sustainability**
  - Most antimicrobial coating agents are biobased, which are either edible or biodegradable, and in this way, antimicrobial food packaging promotes both types of sustainable food packaging, edible and biodegradable.

#### SilverShield by Microban

- **Efficiency**: Reduces up to 99.9% of *Salmonella enterica*, *E. coli*, MRSA and VRE
- **Compatibility**: Microban® silver technology is suitable for materials such as polymers, coatings, ceramics, and more.

- **Key Benefits**
  - **Durability**: Remains effective even if a treated object is nicked or scratched
  - **Non-Leaching**: Stays inert until it meets bacteria

#### Emerging Technology

- The antimicrobial food packaging is an emerging technology. The current applications of antimicrobial food packaging are somewhat limited, although promising. This is because of the legal status of the tested additives.
- Research on antimicrobial packaging is focused on developing various methods and model systems, which will work as fuel on the fire for antimicrobial food packaging in the upcoming time.
10. Nanotechnology in Food Packaging

Improving shelf life and reducing food waste

- Nanotechnology is the science of minimal **materials** that significantly impact the **food industry**, including packaging. A variety of nanomaterials such as silver nanoparticles, titanium nitride nanoparticles, nano-titanium dioxide, nano zinc oxide, and nanoclay are introduced as **functional additives to food packaging**.
- The rapid **advancement of nanotechnology** has provided opportunities for developing new **sensing and food packaging** solutions, addressing long-standing challenges in the food sector to **extend shelf-life, reduce waste, assess the safety**, and improve the quality of food.

<table>
<thead>
<tr>
<th>Benefits of Nano Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interactive:</strong> Packaging with nano-sensors helps identify internal and external conditions of food and containers throughout the supply chain. Also, in plastic packaging, nano-sensors can detect gases in nutrition when it spoils, and as a result, packaging changes the color to alert the consumer.</td>
</tr>
<tr>
<td><strong>Barrier Property:</strong> Films packed with silicate nano-particles can lessen the flow of oxygen into the pack and leak moisture out of the pack. As a result, it protects the package from spoilage. Packaging waste associated with processed food can be reduced by nanotechnology and hence assist the preservation of fresh food</td>
</tr>
<tr>
<td><strong>Product Shelf Life:</strong> Nanotechnology is used to produce smart packaging for extending the shelf life of a product, and the product can be transported further. The antimicrobials and nano-sensors are developed in intelligent packaging to detect food spoilage and release nano antimicrobials to extend shelf life.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Combination of All Packaging</th>
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</thead>
<tbody>
<tr>
<td><strong>Sustainable Packaging</strong></td>
</tr>
<tr>
<td>• Temperature and Moisture Stability</td>
</tr>
<tr>
<td>• Mechanical Strength</td>
</tr>
<tr>
<td>• Durability</td>
</tr>
<tr>
<td><strong>Improved Packaging</strong></td>
</tr>
<tr>
<td>• Anti Microbial</td>
</tr>
<tr>
<td>• Antioxidant</td>
</tr>
<tr>
<td>• UV Absorbance</td>
</tr>
<tr>
<td><strong>Nano Food Packaging</strong></td>
</tr>
<tr>
<td>• Bio-degradable</td>
</tr>
<tr>
<td>• Biocompatible</td>
</tr>
<tr>
<td>• Low Waste</td>
</tr>
<tr>
<td><strong>Active Packaging</strong></td>
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<td><strong>Smart Packaging</strong></td>
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<thead>
<tr>
<th>Authority Initiative</th>
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<tbody>
<tr>
<td><strong>NanoPack</strong></td>
</tr>
<tr>
<td>NanoPack is an EU-funded project, which aims to develop and demonstrate a <strong>solution for extending food shelf life</strong> by using novel <strong>antimicrobial surfaces</strong> applied in <strong>active food packaging products</strong> with the help of nanotechnology.</td>
</tr>
<tr>
<td>The used technology will minimize the number of <strong>preservatives</strong> required to maintain freshness, add value and assure safety to the entire supply chain. The project will employ natural Halloysite Nanotubes (HNTs) as reliable and safe carriers of bio-active compounds which are unable to migrate from the food packaging into food.</td>
</tr>
<tr>
<td>NanoPack will help reduce the staggering 1.3 billion tones of food wasted each year, which cause major economic loss and significant harm to the world’s natural resources. The project intends to present better performing, safer and smarter products that will position Europe as the leader in food nanotechnology and smart antimicrobial packaging while increasing competitiveness and growth.</td>
</tr>
</tbody>
</table>

- Improved Packaging
- Nano Food Packaging
- Active Packaging
- Smart Packaging
- Sustainable Packaging
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