STARFRIT'S GOURMET ECO JUICE EXTRACTOR

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Starfrit's Gourmet ECO Juice Extractor

A technical report with thorough study into the ease of Use, functionality and environmental impact of a wheat husk and propylene polymer juice Extractor.

Prepared for
Starfrit's Product Development Department

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Executive Summary

This report provides a comprehensive engineering analysis of the Gourmet ECO juice extractor. Using structured tests, case studies, and validated references, it evaluates the product's performance across three critical areas of study: *ease of use*, *functionality*, and *environmental impact*. Each area of study is presented in its own dedicated section with findings and design recommendations are provided in the recommendations section. All technical and engineering terminology is defined in an *italicized* glossary for clarity.

Ease of Use this section consists of evaluation of the juicer's ease of use. It showed that the product is highly intuitive, simple to operate, and accessible for first-time users. Testing with individuals of different backgrounds confirmed that the two-component design allows users to assemble, disassemble, and clean the juicer with minimal instruction. The one-orientation fit of the reamer supports correct usage and reduces assembly errors, while the large surfaces make cleaning straightforward, with the only noted challenge being pulp buildup in the strainer. Ergonomic testing indicated that the reamer accommodates a wide range of hand sizes, although the handle is better suited for small to medium hands. Time-to-juice observations revealed that users with lower strength typically required more time and effort, suggesting that improved ergonomics would benefit overall performance. Enhancements such as a larger handle or rubber feet would increase comfort and stability while also reducing unnecessary loading on the product, although these improvements would lead to an increase in manufacturing cost.

Functionality and Effectiveness in this section is a testing that showed that the Starfrit Gourmet ECO Juice Extractor functions effectively and performs close to expected juice yields. Juicing ten lemons produced 390 milliliters in just over four minutes, which is similar to values reported by external sources. The reamer and reservoir design worked efficiently, the spout poured cleanly with no drips, and the strainer successfully blocked seeds with only minor pulp buildup after several uses. Juice output varied naturally due to differences in lemon size, ripeness, and moisture content. Overall, the extractor performs reliably and meets functional expectations, with possible improvements including a finer strainer and size-specific reamer options.

Environmental impact this section consists of how the Starfrit Gourmet ECO Juice Extractor is largely influenced by its wheat husk and polypropylene composite. Wheat husk is a biodegradable agricultural by-product that is normally burned, so incorporating it into the plastic matrix reduces waste and avoids additional carbon emissions. Polypropylene itself is not biodegradable but is fully recyclable and blending it with forty percent wheat husk lowers the amount of virgin plastic required. The product's simple two-part construction limits material use and reduces manufacturing energy, with injection molding being the only major process involved. Although farming and plastic production still create emissions, the composite design decreases overall environmental burden and supports easier end-of-life disposal through composting or recycling.

Conclusion The findings from this report are listed in this section. It shows that the Starfrit Gourmet ECO Juice Extractor performs well across ease of use, functionality, durability, and environmental impact. User testing confirmed that the design is intuitive and effective, producing juice outputs that closely match expected values while maintaining reliable performance during repeated use. The polypropylene and wheat husk composite also provides meaningful environmental benefits by reducing plastic content and supporting recyclable or compostable end-of-life options. Overall, the product meets its intended purpose with strong usability and acceptable performance. That being said, Opportunities still remain in ergonomics, reamer optimization, filtration efficiency, material strength and manufacturing energy use.

Recommendations this section includes suggestions based on usability testing, functional evaluation and environmental analysis of the juice extractor that are believed to improve the product's Stability, Enhance Ergonomics, improve extraction efficiency, refine filtration, increase material durability and reduce manufacturing energy use.

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Introduction

This report evaluates the Gourmet Eco Juice and identifies areas of improvement and product's design strength points.

Purpose and Scope

The purpose of this technical report is to evaluate Starfrit's Gourmet Eco Juice Extractor on behalf of Starfrit to provide the company with product's strength and possible improvements. This report will examine the product's material selection, its mechanical properties and design choices made to have a better understanding of the juice extractor and directly compare to how it should ideally be used and be manufactured as an easy-to-use, functional, environmentally friendly kitchen tool. This report discusses those ideal areas of study based on the results from examinations and thorough research into various sources. This report does not intend to include the product's ergonomics, aesthetics, durability and costs related to purchase, transportation or manufacturing. Additionally, this report does not include product comparisons of juice extractors manufactured by other companies.

Background

Many sources refer to Dr. Norman Walker, a British nutritionist as the first advocate for fruit juice as a healthy form of snack to be the designer of the first juice extractor. “This groundbreaking appliance, named after him, revolutionized home juicing by employing a hydraulic press for maximum juice extraction” [1].

Juice Extractors have diverse use cases commercially, in factories or the personal kitchen requiring them to have different mechanisms to produce juice. Mechanisms like manual level press using a level and fulcrum system to multiply force applied by the user, centrifugal juicing mechanism utilizing a high-speed rotating blade or grater to shred fruit, masticating (slow) juicer to slowly crush and squeeze fruits through a filter or hydraulic press to apply hydraulic pressure through a piston or plate to compress pulp inside a filter cloth or a bag. Gourmet ECO juice extractor is a juice Extractor made by Atlantic Promotions Inc under their Starfrit brand's biodegradable kitchen supply line [2].

Methods

Methods employed when researching the item Included using online articles, websites, material specifications, product information, studies, surveys, and experiments. Some computer aided designs were made for better understanding the product and to generate a Fine Element Analysis.

Technical Description

The Gourmet ECO requires the user to place a half cut spherical fruit's circular cross section on the reamer then apply a downward force and torque simultaneously while holding on to the juice extractor's ergonomic handle. As a result, juice is squeezed out due to mechanical compression against the reamer's ridges by causing the juice sacs to rupture through compressive stress. The torque applied by twisting the fruit around the cone's central axis creates shear stress that tears the fruit's pulp and enhances juice flow. The juice then flows through the strain and to the reservoir while the pulp and seeds remain on the strain. The Gourmet Eco Juice Extractor is made of Wheat husk and propylene polymer which makes it an amazing environmentally safe, recyclable and compostable material [3].

Components

The Gourmet Eco is made with natural wheat straw husk fibers as well as a *BPA-free polypropylene plastic* and comes with two components: **a base** and **the cone shaped reamer**.

The Base

The Base of the Juice Extractor serves as a reservoir that stores the juice extracted from the fruit. The Gourmet Eco's base has a large capacity of 28.7 oz (850ml)

It comes integrated with a pouring spout for a mess free pour and an ergonomic handle for simplified pressing process.

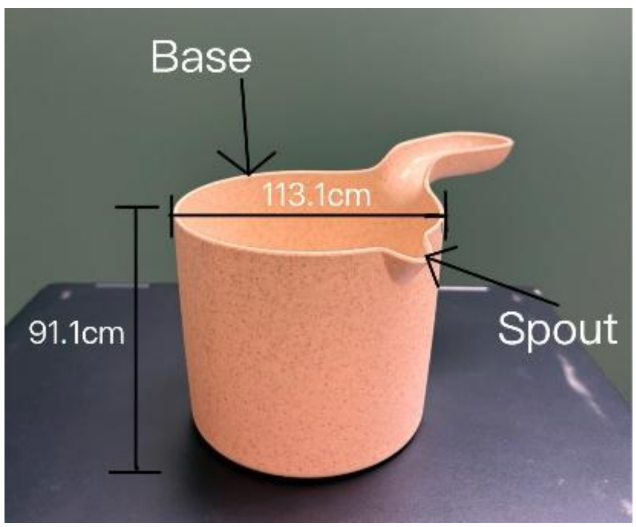

Figure 1 - Gourmet ECO Juice Extractor Base

The Reamer

Designed with ease of use and ergonomics in mind, the reamer is made with a cone shaped reamer surrounded with a strain.

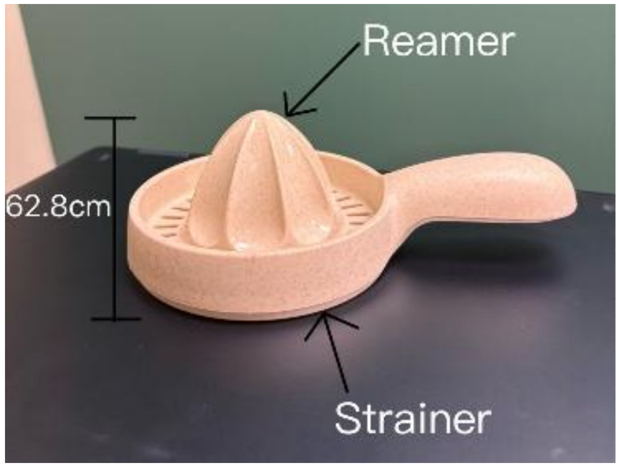

Figure 2 - Gourmet ECO Juice Extractor Reamer

Wheat husk and its polypropylene plastic composite material properties

The material properties table is populated using a study done on *Physical, chemical and surface properties of wheat husk, rye husk and soft wood and their polypropylene composites* and is summarized from [4].

Table 1: Wheat Husk Material Properties

10	Symbol	Typical Value
Density	ρ	950–1100 kg/m³
Elastic Modulus (Tensile)	E	2.2–3.5 GPa
Tensile Strength	σt	22–38 MPa
Flexural Modulus	Ef	2.0–3.3 GPa
Flexural Strength	σf	30–50 MPa
Impact Strength (Izod, notched)	an	20–35 J/m
Poisson's Ratio	v	0.34
Shear Modulus	G	0.82–1.1 GPa
Coefficient of Thermal Expansion	α	(8–12) $\times 10^{-5}$ /°C
Thermal Conductivity	k	0.25–0.32 W/m·K
Specific Heat	cp	1900–2100 J/kg·K
Tensile Elongation	εt	2–5 %

Ease of Use

Understanding ease of use of a product is key to how it will perform and will survive in the market. Catering to all kinds of people leads to the success of a product. To gain meaningful insight into the juice reamer, trials were conducted with varying kinds of individuals, spanning from people with smaller hands all the way to big hands, physically strong and physically weak, etc. Through these trials brought useful information and meaningful insight into the juice reamer. Everything that follows is what was gathered through all the trials.

Intuitiveness

After conducting some trials with six individuals aging from 19-51, most users were able to operate the juicer with ease. Indicating that the overall design of the juicer is very user friendly and intuitive. The participants reported that no instruction was needed to figure out how to work and use the juicer. They were easily able to identify the main components of the product and were able to use it with minimal effort. After some feedback from the participants, they have said that since the reamer cap and the base only fit a certain way, eliminating any type of confusion on disassembling and reassembling of the product.

How it accommodates

During testing of the juicer with the six participants of varying hand sizes and strength levels, the juicer demonstrated a good level of ergonomics. The participants with the smaller to medium sized hands reported that the contoured design of the handle suit their hand very well, comfortable to use and helped them have a secure grip. On the other hand, the participants who had larger hands found it a bit more difficult to use as the grip was too small for them. The two individuals who had the larger hands had said that they felt a bit restrictive as it was hard for them to get a good secure grip of the juice reamer, thus requiring them to use more effort to operate the product. Aside from the handle, the reamer component of the juicer was able to effectively accommodate all the users. Everyone was able to apply sufficient force and rotational motion without any discomfort. The overall shape of the reamer was able to handle even larger fruits, meaning that even the individuals with larger hands were able to comfortably use the reamer.

Figure 3 - Starfrit Pouring

Assembly, Disassembly and Cleaning Process

Since the juicer is only composed of two main components, users experienced a highly intuitive assembly and disassembly process. During testing with the six individuals, everyone was able to take the juicer apart and reassemble it without any difficulties. Additionally, the individuals have reported that the manufacturing and design of the juicer is what made is very simple to put together. The juicer's two components fit in only one orientation, thus eliminating confusion. The cleaning process was also very straightforward. All users were able to easily clean the juicer without many difficulties. This is due to the juicers two parts that are equally large. According to the individuals, the only problem that was evident was cleaning the strainer of the juice. Pulp occasionally became trapped in the small gaps, requiring a bit more time and effort to clean. Aside from this, each participant found the cleaning process of the juicer to be very simple.

How do improvements in ergonomics affect durability and cost?

Improvements in ergonomics for the juicer can be added but at an increase of overall manufacturing cost. Enhancing ergonomics would reduce the physical effort required to use the juicer, meaning lower stresses transferred into the actual product, thus improving the overall durability. An area to improve regarding ergonomics would be the handle, having a larger handle would help accommodate for users with larger hands. The juicer comes with a small to medium size handle which feels very limiting and restrictive to users which larger hands. Another area that the juicer can be improved on is adding rubber feet on the bottom to prevent it from slipping. Implementing this change would increase the comfort and control of the juicer as it eliminates the need to firmly press down right in the middle of the reamer to make sure that the juicer does not slip and spill. Overall, enhancing ergonomics and the design of the juicer would benefit every user, but it would increase the manufacturing cost of the product.

Functionality and Effectiveness

This area of the report will investigate the functionality of the Starfrit Gourmet ECO Juice Extractor through means of testing and researching from external sources. To begin, the base reservoir is a very significant design feature, allowing users to directly capture extracted juices without needing to squeeze over or into a different catching medium. Another important feature of the base reservoir is the spout formed into the edge. This makes it so that the extracted juices can be poured easier and reduce spills. Moving to the top half, the reamer is the central conical feature with ridges along the surface. Around the reamer is the strain to catch any byproducts during use. The last notable design feature is the handle which is split between and shared by both pieces when separated, and fully functional when the assembly is together.

Functionality of Juice Extraction

The primary aspect of understanding the functionality of the tool is to use and observe it. Examining the effectiveness of the Starfrits design, it was put through a similar test to a study done comparing effectiveness of citrus juicers on 10 lemons [5]. The results of the study done using the Starfrit are shown in the table below:

Table 2 - Test results from juicing 10 lemons using the Starfrit

Time to Juice	Ave. Time per Lemon	Juice Yield	Ave. Juice per lemon	Total Filtered By-product Weight	Average Filtered By-product Weight Per Lemon
4 minutes 4 seconds	**24.2 seconds**	**398 grams / 390 ml**	**39.8 grams / 39.0 ml**	**123 grams**	**12.3 grams**

This displays how much juice can be obtained and how long it takes. Also to be noted that this disregards setup time and lemon cutting time.

Some other data taken from individual lemon juicing trials to gauge effectiveness during the study was retrieved:

Table 3 - Self sourced study on juice to weight ratios for lemons using the Starfrit

Trial #	Net Weight	Juice Weight	Net By-product Weight	Juice Weight - Net Weight Ratio	Specific Juice Weight (grams of juice / gram of lemon)
1	125 g	47.0 g	78.0 g	47:125	0.376
2	119 g	36.0 g	82.5 g	36:119	0.303
3	119 g	36.5 g	82.5 g	73:238	0.307

4	122 g	44.0 g	78.0 g	22:61	0.361
Averages:	**121 g**	**41.0 g**	**80.3 g**	**41:121**	**0.339**

Theoretical Discussion

As an alternative source, according to [6], the average amount of juice extracted is approximately 3 tablespoons or 44.4 ml of juice per 1 lemon. However, based of data from [7], to gauge effectiveness is from a juice yield calculator site, the estimated amount of juice per 10 lemons is 428 ml.This is around 10% more than achieved from the study, being 390 ml. So it compares roughly to expected amounts of juice extracted.

Also worth noting, the amount of juice in a citrus fruit can be a difficult measurement to properly quantify based on numerous factors which affect juice yield. Firstly, ripeness of a citrus fruits affects the amount of juice in a they contain. This is because they are *non-climacteric* which means that the fruit follows a gradual ripening process and will not ripen once harvested from the plant [8]. Fruits will begin to soften during ripening from enzymes that breakdown structures within the cell walls [9]. In turn, a underripe fruit will be harder and juice will be more difficult to extract. Secondly, if a lemon is freshly harvested, it will usually have more juice than a lemon that has been in storage due to the lemon beginning to dry out. Weight and size of the lemons will also affect the amount of juice because typically a larger or heavier lemon will yield more juice, however that may not always be the case.

Effectiveness of the Strain

To start, most typical lemon seeds are around 9.5mm and are “small ovoid, and pointed” [10]. Depending on the width of the lemon seeds, they may or may not pass through the strainer. To answer this fully, the strainer effectiveness was monitored during testing, and it was noted that regular seeds are all filtered out effectively due to the measurements of the slots, which are 4 mm wide, much less than the average lemon seed size. However, there are some irregularities that may pass through, including flaking of seed shells which can form by the reamer during use, as well as some amounts of pulp small enough to pass through. Additionally, effectiveness of the strain can also be linked to time in use. During testing at around 4 – 6 halves of lemons used, the pulp would start blocking juice drainage through the strainers and need to be removed for comfortable use. To evacuate the blockage of pulp and seeds, the removable reamer half can be taken off and hit against a surface or on the edge of a bowl to catch the contents.

Spout Effectiveness

During testing, when pouring liquid from the spout there was virtually no *teapot effect*, and the pour was extremely smooth. There was also no difference whether the reamer half was on during the pour or off. *Volumetric flow rate* was also no issue: no issues with drippage from pouring at different speeds.

Long Lasting?

Based on the use of the citrus reamer, it should have good longevity. This is because it is being used on relatively soft fruits and is spread across most of the surface area of the fruit during use. This makes it difficult for there to be any deformation in the material of the tool. A possible counter to this would be having the seeds in citrus fruits degrade the juicer overtime through repeated use due to the seeds being small, hard, and having concentrated forces on tiny areas, that is higher pressure.

Environmental Impact

The materials that are used in the juicer includes a mixture of polypropylene plastic and wheat husk. Wheat husk is the outer layer of the wheat grain that acts as a protection layer from the actual wheat inside. Because it is a natural resource coming from crops, it is biodegradable. However, it is also used in a multitude of other cases such as water decontamination, the production of *biofuel* and in this case the creation of plastic composites [9]. Although the polypropylene plastic is not biodegradable, it is recyclable. The issue with this is that it contributes a significant amount of waste in the ecosystem for millions of years due to its long *half-life*. Wheat husk and polypropylene creates a composite that is extremely bio-friendly as it uses less *fossil fuel-based virgin plastic* [10]. This composite is also completely compostable and recyclable which means that also contributes positively towards the environment.

Carbon footprint of the Juicer

Wheat husk is commonly disposed of through incineration, a process that releases CO_2 into the atmosphere. Integrating wheat husk into the Gourmet ECO composite diverts it from being burned, resulting in a reduced carbon emissions associated with traditional disposal. Thus, the main impact would come from the manufacturing of the propylene plastic and the harvest of the wheat husk. The processes that come with creating the final product comes from the *injection molding* the plastic which is the only major manufacturing process in the juicer.

Utilizing the total mass of the juicer to be 0.1535 kg, the formula for energy consumption of the juicer is as follows:

The Total cost to *injection mold* one kilogram of PP Plastic is **2.6 (kWh/kg)^12** [15], *this is a given value in tables*. The juicer weighs at **0.1535 kg** which can be rounded to **0.15 kg.** If the juicer weighs less than a kilogram, to calculate how many juicers can be molded per one kilogram, simply divide **1 kg / 0.1535 kg** to get a value of **6.5**.

Rounding down that value it gives us an approximated value of 6 Juicers that can be made to be made per **2.6 (kWh/kg)^12**.

Aside from just the manufacturing process, there is also factors when it comes to harvesting the wheat, since farming also creates carbon emissions as well.

Recyclability And Biodegradation

The Juicer comes with a fitting reamer and base. It does not include any extra parts like fasteners which makes it extremely easy to assemble and disassemble. For repair on the other hand, because it is a plastic-based material, deformations can’t be easily repaired without melting or remoulding. Recycling works the same way as any other plastic which makes it an optimal choice for material.

An Alternative material that could be explored would be wheat straw PP. It is very similar to the composite material except it uses the straw from the wheat. The benefit of this material would be the fact that it uses woven fibres (Around 30-50%) Mixed with Either *PLA* or in this case Polypropylene. It keeps its biodegradable and recyclable properties while increasing the strength which in turn will also increase the overall lifespan of the materials, meaning it will be kept out of the landfill for longer. [10]

Life Cycle and Sustainability

The Complete life cycle of bio-composites is as follows.

1. First step is the sourcing of the raw materials, in this case it would be the collection of wheat husk after the wheat is extracted from it. But bio plastics can be made from other materials such as Sugarcane, corn, etc.
2. The second step is mixing the materials together which is accomplished via mixing and temperature control [11].
3. Next is the *injection molding* process where the shape of the juicer's components takes place [11].
4. Next would-be final refinement such as sanding sharp edges and checking for imperfections before it can go off into the market.
5. Once bought it all depends on the user but ultimately once its broken or used it is up to the owner to decide how to dispose of the juicer via composting or recycling

The overall sustainability of this material is very positive for the environment because it is very easy to dispose of with multiple methods. The first method is general composting which allows people to deal with plastic waste in a more environmentally friendly way instead of waiting millions of years for the polypropylene to naturally degrade on its own. The second method is recycling it because it still is also a plastic. The way that the material is created isn't just environmentally friendly at the end of its life cycle too, at the beginning it takes wheat husk that would otherwise be burned and polypropylene plastic to create a matrix that allows to use up non disposed wheat husk and make a plastic with less plastic in it which means when making the juicer, because the ratio of wheat husk to plastic is 40:60 [10], it uses 40% less plastic overall.

Conclusion

Overall, the Starfrit Gourmet ECO juice extractor demonstrates strong usability and satisfactory functional performance. The reamer's intuitive geometry and contoured handle support users with small–medium hands, though users with larger hands experienced reduced comfort and control. Despite this limitation, the overall size of the reamer accommodated all users, and the two-piece assembly allowed for fast and effortless cleaning.

Functionally, the juicer performed reliably in yield, filtration, and spout behaviour. The average juice extraction per lemon was **39.0 mL**, with an average processing time of **24.2 seconds**, slightly below theoretical expectations but consistent with comparable manual extractors. The strainer removed most by-product, with an average of **12.3 g** of pulp per lemon being generated, though small unfiltered particles still entered the juice. The spout demonstrated strong accuracy with no detectable *teapot effect*.

Environmentally, the product is made from a polypropylene–wheat husk composite, offering a recyclable plastic matrix and biodegradable filler. This reduces overall CO_2 emissions compared to pure virgin plastic and provides an environmentally beneficial disposal pathway. However, the composite's lower durability and reduced mechanical strength limit the product's long-term lifespan. Manufacturing processes also present opportunities for further carbon-reduction.

In summary, the main areas for improvement include:

- The handle is comfortable for users with small or medium hands but less effective for users with larger hand
- The reamer size is not suitable for all citrus types, which reduces juicing efficiency.
- The strainer allows small pulp particles to pass through and produces a relatively high amount of byproduct.
- The polypropylene and wheat husk composite is environmentally beneficial but lacks long-term durability.
- The current manufacturing process uses more energy than necessary and could be made more efficient.

Recommendations

The evaluation of the Gourmet ECO juice extractor showed that the product performs well in ease of use, functionality, and environmental benefit. The handle design works effectively for most users, although individuals with larger hands experienced reduced comfort. The reamer provides consistent juice extraction, but its size is not ideal for all citrus types, which affects efficiency. The strainer removes most byproduct but still allows some pulp to pass through. Environmentally, the polypropylene and wheat husk composite reduces carbon emissions by diverting agricultural waste from burning, although the material is not highly durable. The current manufacturing process consumes more energy than necessary and could be improved.

Critical recommendations which are believed to be implemented as soon as possible include:

- Redesign the handle to improve comfort for users with larger hands
- Add a rubberized or high-friction base to prevent slippage during juicing
- Optimize reamer size by providing versions suited to different citrus types
- Introduce a finer strainer to reduce pulp entering the juice
- Improve material durability by reinforcing the wheat husk composite
- Lower manufacturing energy consumption by switching to blow molding

Beyond the critical improvements listed above, several secondary enhancements can further strengthen the product's performance. For users who require pulp-free juice, an alternative extraction mechanism such as a geared press may be more suitable, since the reamer design naturally generates pulp. Offering multiple reamer sizes would allow the juicer to be tailored more specifically to household usage patterns. The use of woven wheat-straw fibers can preserve environmental benefits while increasing structural lifespan. Adjusting the manufacturing process to reduce energy requirements would also contribute to a smaller carbon footprint and greater production efficiency.

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Glossary

Biofuel: A fuel derived directly from living matter.

Bisphenol A (BPA): a chemical sometimes used in plastics and resins that can leach into food or liquids.

Blow Molding: A manufacturing process that is used to create hollow parts by inflating a tube like piece of plastic called a parison inside a mold.

BPA-Free Polypropylene: A type of plastic made from polypropylene (PP) that does not contain *bisphenol A (BPA)*. BPA-free polypropylene is non-toxic, lightweight, and recyclable.

Finite Element Analysis (FEA): A computer-based method used to simulate and evaluate how a product responds to physical forces such as stress, vibration, or heat.

Fossil fuel-based virgin plastics: Plastic that has been produced from raw, fossil-based materials primarily crude oil or natural gas and has never been used, processed, or recycled before.

Half-life: The time taken for the radioactivity of a specified isotope to fall to half its original value.

Injection molding: The shaping of rubber or plastic articles by injecting heated material into a mold.

Non-climacteric: Refers to fruits that do not exhibit a significant increase in respiration or ethylene production during ripening.

Polylactic acid (PLA): A biodegradable and bioactive polyester made up of lactic acid building blocks

SolidWorks: A computer-aided design (CAD) and simulation software used for 3D modeling and Teapot Effect: Refers to when pouring liquid from a containing body and the liquid runs down the side of the body instead of forming a smoot

Volumetric Flow Rate: Volume of fluid that passes through a given point in a system per unit of time.