Tooty Fruity
Sustainable Packaging Report

by
Rachel Dring

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Contents

1. Aim & scope

The aim of this paper is to assess the environmental impact of the packaging Tooty Fruity (TF) currently uses, explore what other options are available that have a lower carbon footprint and that produce less waste. Outline the best options for TF going forward, presenting a clear rationale for their environmental advantages and suitability for the product.

The research and recommendations arising in this paper will be used for Tooty Fruity's internal decision-making and to share with customers. The research is UK-centric, as Tooty Fruity's products are currently distributed and consumed only within the UK.

2. Method

We will compare the latest research into food packing materials to assess the various options available for Tooty Fruity's products, taking the following environmental considerations into account:

- Direct environmental impacts caused by the production and disposal of packaging.
- Indirect environmental impacts caused by packaging-related food loss and waste (FLW).
- Circularity of packaging – how reusable/recyclable it is

We have reviewed Life Cycle Analysis (LCA) papers to understand the impact of each packaging option – LCA is a complex technique to quantify the environmental impact of a single product over its whole life cycle, from the raw materials, energy and resources used for manufacture and transportation and the reuse, recycling and final disposal of packaging. LCA typically describes impacts such as global warming potential (GWP), human toxicity potential, and ecosystem toxicity potential.

The advantage of LCA is that it takes into account the processes that are invisible to the consumer, and client, such as resource extraction, environmental damage of agricultural methods and transportation of packaging. While there is much public awareness of plastic waste pollution and understandable concern about the toxicity impacts of plastic particles permeating soils and waterways, from a climate change perspective, waste management contributes a very small fraction of greenhouse gas (GHG) emissions. A recent study into GHG emissions in the US found that waste management contributes only about 2 percent of annual U.S. greenhouse gas (GHG) emissions[1], while the full life cycle impacts associated with the provision of food and consumer goods represents 42 percent of the nation's annual GHG emissions[2].

This suggests that the manufacture and transportation of the packaging needs careful consideration, not just how it is disposed of.

Life Cycle Analysis

The findings of several LCA studies of food packaging were reviewed. These studies consider each material against five key Life Cycle elements:

1 U.S. Environmental Protection Agency's GHG inventory 2017
2 U.S. EPA Office of Solid Waste and Emergency Response 2009

1. Resource extraction & raw material production

Things to consider: how the raw materials are extracted, are they renewable sources, if they are plant-based, have they been produced using organic or conventional methods and if land use change is involved, how this impacts food supply

Raw material production usually contributes the greatest proportion of impacts to the overall life cycle of packaging for all results categories typically included in LCAs[3]

2. Packaging production: Energy use & pollution from manufacture

How much energy and water is used in the making of the packaging? How polluting is the manufacturing process?

3. Transportation

The weight and bulkiness of a packaging product will impact the amount of C02 needed to transport it from the factory to the customer. Lightweighting is one strategy for reducing the environmental impact of a packaging product - using thinner gauges of packaging materials either by reducing the amount used or by using alternate materials

4. How effectively they preserve/protect the food

Package design and construction play a significant role in determining the shelf life of a food product. Food waste is more significant than packaging waste in terms of climate change. In the UK food waste is responsible for over 20 MtCO2e whereas all packaging in the UK including non-food packaging is responsible for 17.4 MtCO2e[4]. It's important to consider how well the packaging option maintains product quality and freshness during distribution and storage. Since food waste is also a key producer of greenhouse gas emissions, it's also essential that packaging provides and effective barrier, that preserves food.

5. End of life: Reuse, recycling and composting

What are the end of life options for the packaging? Can the packaging be reused? How readily can they be recycled or composted? If it's recycled, can it be recycled back into it's original form or is it downcycled into a lower-quality form. Recycling rates must also be considered - even though something is recyclable, it doesn't always mean it actually gets recycled – behavioural and infrastructure barriers are another factor to consider.

Compostable materials are generally not recyclable. So, recyclability and compostability are currently mutually exclusive options.

3. Assessing the environmental impact of different packaging options

All of the LCA papers reviewed found that plastic presented the lowest impact.

3https://www.academia.edu/37383590/The_Significance_of_Environmental_Attributes_as_Indicators_of_the_Life_Cycle_Environmental_Impacts_of_Packaging_and_Food_Service_Ware_Final_Report P.8
4 http://www.wrap.org.uk/sites/files/wrap/UK%20Estimates%20October%2015%20%28FINAL%29_0.pdf

A 2016 study for the American Chemistry Council by Trucost assess the environmental cost of plastic and its alternatives, and considered how more sustainable practices could help reduce the environmental costs of plastic use in the consumer products sector

They found in most cases the environmental cost per kilogram of alternative material is less than that of plastic. However, on average over four times more alternative material is needed (by weight) to perform the same function[5]. The environmental cost of plastic in consumer goods was found to be 3.8 times less than the alternatives materials that would be needed to replace plastic. For example, a typical plastic drink bottle contains 30 grams of plastic. But if replaced by a weighted average mix of alternative materials currently used in the market, an equivalent capacity bottle would require 141 grams of alternative materials such as glass, tin or aluminium.

An earlier 2009 study using the total life cycle energy consumption (from raw materials in the ground through ultimate disposal as an indicator) flexible plastic packages were found to offer energy savings of 30 to 87 percent over the alternatives assessed for similar product applications[6]

3.1 Tooty Fruity's current packaging

Tooty Fruity currently uses plastic trays made from PET.

What is PET?
PET is an acronym for Polyethylene Terephthalate and it is best known as the clear plastic used for water and drinks bottle containers. As a raw material, PET is a petroleum-based product that is globally recognized as a safe, lightweight, and flexile material that is also 100% recyclable. In fact, PET is the most widely recycled plastic in the world. In the UK in 2016 76% of PET was recycled, however, it's estimated that only 33% of pots, trays and tubs were recovered for recycling[7].

TF's current packaging conforms to the WRAP best practice guidelines[8] for PET trays, being made up of at least 50% recycled plastic, using clear plastic and only one type of plastic, and having a label that is minimum 40% of the overall package area.

3.2 Plastic

Multiple types of plastics are being used as materials for packaging food, including polyolefin, polyester, polyvinyl chloride, polyvinylidene chloride, polystyrene, polyamide, and ethylene vinyl alcohol. Polyolefins and polyesters are the most commonly used as packaging materials.

5 https://www.academia.edu/36590825/Plastics_and_Sustainability_A_Valuation_of_Environmental_Benefits_Costs_and_Opportunities_for_Continuous_Improvement

6 https://www.cga.ct.gov/env/tfs/20170216_Task%20Force%20to%20Study%20Methods%20for%20Reducing%20Consumer%20Packaging%20that%20Generates%20Solid%20Waste/20170719/Flexible%20Packaging%20Association%20-%20Sustainability%20Assessment%20of%20Flexible%20Packaging.pdf

7 https://www.bpf.co.uk/packaging/recycling.aspx

8 http://www.wrap.org.uk/sites/files/wrap/Polymer-Choice-and-Recyclability-Guidance.pdf#page=11

Polyolefins Polyolefin is a collective term for polyethylene and polypropylene, the 2 most widely used plastics in food packaging

Raw Materials

Plastic is made directly from fossil fuels, a non-renewable resource. It is estimated that 4% of the world's oil production is used as a feedstock to make plastics. It is, however, important to understand that a lot of plastic, LDPE #4 or "plastic bags" in particular, are made from ethane, a byproduct of natural gas production. Ethane would be typically burned off to lower the BTU value of the gas so that it doesn't burn too hot when used as fuel in our homes and businesses. The production of plastic in this way actually "captures" this ethane instead of having it burned and released into the atmosphere.

Recycling and disposal/end of life

While there is much public awareness and concern about plastic pollution in marine environments, it's estimated that 10% of this litter is from industrial fishing vessels dumping old fishing lines and nets[9], and the vast majority of the rest of the litter is single-use packaging and food service ware from countries with improper waste management systems[10]. Schmidt and colleagues assessed the flow of plastic debris from rivers to the ocean and found that 10 large watersheds, 8 in Asia and 2 in Africa, with large populations and insufficient waste management services contribute over 90 percent of the plastic mass released to the ocean annually. The top 20 countries contributing to waste plastic in oceans are Asian and African countries. There is one high income country on the list, the United States.

In the UK plastic mostly ends up being recycled or landfilled.

Current recycling rates:

National figures suggest that 31% of all plastics are recycled[11]

Looking more locally to where Tooty Fruity's operations are based, North London Waste Authority recycling rates – less than 20% of household waste is recycled in North London. 52% of that is paper and card and 10% is plastic[12]

What are the barriers to recyling?

Access to recycling bins and awareness of recyclability. TF products are positioned as an on-the-go snack, less likely to be consumed at home and therefore less likely to be placed in home recycling bins, therefore relying on the provision of recycling bins in public places.

How to further reduce the environmental impact of plastic

9 http://www.fao.org/in-action/globefish/fishery-information/resource-detail/en/c/388082/

10 Schmidt, Christian, Tobias Krauth, and Stephan Wagner. 2017. "Export of Plastic Debris by Rivers into the Sea." Environmental Science & Technology 51 (21): 12246 – 53. https://doi.org/10.1021/acs.est.7b02368

11 https://www.bpf.co.uk/sustainability/plastics_recycling.aspx

12 http://www.nlwa.gov.uk/media/2757/recycling-services.pdf

1. Choose a manufacturer that uses a low-carbon energy source

Over 48% of greenhouse gas emissions, 12% of land and water pollutant costs, and 86% of air pollutant costs associated with the plastic manufacturing sector (both directly and among direct suppliers) are linked to the purchase of electricity, predominantly from fossil fuel sources. By increasing the share of electricity sourced from low carbon energy sources such as wind, hydro, solar and geothermal, the plastic manufacturing sector can significantly reduce its environmental cost footprint[13]

2. **Resource efficient design**

Ensuring you're using the lowest weight of plastic possible (lightweighting) and being minimalist, using a minimal mixture of materials, paper stickers, glues etc.

For instance, a package that includes a plastic pot in a paperboard sleeve is going to have more than double the environmental impact of just using a plastic pot.

To further reduce the impact of Tooty Fruity's packaging, it is an option to change the packaging to a lighter weight plastic pouch rather than a semi-rigid PET tray.

Plastic: conclusion

Plastic is the least impactful in terms of the manufacturing process and transportation, as it is the lightest of all the materials. It also is the most effective at protecting and preserving food. However, current recycling rates are low and the impact on human and ecosystem toxicity is high.

3.3 Paper

Paper and paperboards are commonly used in food packaging in the form of corrugated boxes, milk cartons, folding cartons, boxes, bags and cups.

Raw materials

Paper is typically made from trees, though very occasionally from materials like straw or hemp. Trees are a renewable resource, which is good. However, renewable isn’t a great thing if the paper is coming from global deforestation - one of the major contributors to climate change and loss of wildlife habitat. Every year, 13 million hectares of forest disappear (although afforestation adds another eight back), and the World Resources Institute (WRI) estimates that only about 22 percent of the world’s old growth forests remain intact.

So using recycled paper products would have the lowest impact. If using non-recycled paper, FSC certified paper is advised as the best guarantee that forest stocks are managed sustainably.

Energy use & pollution from manufacture

It takes more than four times as much energy to manufacture a paper bag as it does to

13 https://www.academia.edu/36590825/Plastics_and_Sustainability_A_Valuation_of_Environmental_Benefits_Costs_and_Opportunities_for_Continuous_Improvement

manufacture a plastic bag[14]

A typical modern paper machine runs at 1000 metres per minute and uses a lot of energy, water and other expensive resources. In a paper recycling plant any raw material that is contaminated, inefficient or difficult to process reduces the overall viability of high-volume manufacturing, undermining the benefits of recycling paper instead of using virgin materials.

Transportation

Paper and paperboard are heavier and bulkier than their plastic alternatives, therefore requiring more space and energy to transport.

Paper bags generate up to 70% more air and 50 times more water pollutants than plastic bags. It would take approximately seven lorries to transport the same number of paper bags as can be transported by a single lorry full of plastic bags.[15]

How effectively do they preserve/protect the food

Plain paper is not used to protect foods for long periods of time because it has poor barrier properties and is not heat seal-able. When used as primary packaging (that is, in contact with food), paper is almost always treated, coated, laminated, or impregnated with materials such as waxes, resins, or lacquers to improve functional and protective properties. This can reduce it's recyclability.

Reuse & recycling

Paper and card is the most easily and widely recycled material.

It is likely that a paper of card package for Tooty Fruity's products would need to be coated or laminated to ensure the package is durable and preserves food effectively. These additional coatings will affect recyclablility.

When specifying coatings or barriers, make sure they allow board or paper to break down into single fibres in suspension when exposed to water and that plastics and other sealing agents can be easily removed from the fibre. Also ensure that plastics and sealing agents can be dealt with by paper mills and do not compromise the production process, finished paper or environment. Avoid cured UV varnishes and varnishes that breakdown into small or microplastic particles, and metalised films, as the small particles from these can interfere with machinery and contaminate the final product. Use coatings that are soluble in water, such as starch, which paper mills can treat.[16]

Paper: conclusion

Paper is the most recyclable and biodegradable material you can use, but it is more energy intensive in the raw material extraction, manufacture and transportation. However, the need to an additional coating in paperboard to protect and preserve food would degrease it's recyclability.

14 http://www.niassembly.gov.uk/globalassets/documents/raise/publications/2011/environment/3611.PDF
15 http://www.niassembly.gov.uk/globalassets/documents/raise/publications/2011/environment/3611.PDF
16 https://www.wrap.org.uk/sites/files/wrap/Fibre%20packaging%20design%20guide%20v3.pdf

3.4 Bio-plastics

This is a general term for plastics that contain some plant-based material. Often the bio-plastic name can be misleading and cause confusion for both consumer and businesses as there are a few different types of material that can be described as “bio- plastic”. The term “bio” can be used even if it contains a very low proportion of or in fact, no plant-based material. Sometimes “bio” is used to describe an oil-based plastic that degrades.

Raw Materials

Bio-based plastics usually have a lower carbon impact in their extraction and production phase than plastic.[17]

They are mainly derived from corn (starch) or cane sugar. In these cases, in order to assess the environmental impact, the way the crops have been grown must be taken into account. Unsustainable farming practices can contribute to pollution, soil degradation and food insecurity – growing crops for packaging is arguably not a good use of land or resources. And this will have a greater impact on the Life Cycle Analysis than the way the material is produced and disposed of.

Sources of plant based bio-plastic must be assessed also for the raw materials used. Mainly derived from corn (starch) or cane sugar. In these cases, in order to assess the environmental impact, the way the crops have been grown must be taken into account. In most cases the raw materials have been intensively grown in large monocultures, using artificial pesticides and fertilizers[18]. These unsustainable farming practices can contribute to pollution, soil degradation and food insecurity – growing crops for packaging is arguably not a good use of land or resources. And this will have a greater impact on the Life Cycle Analysis than the way the material is produced and disposed of.

Bio-plastics that are made from agricultural waste are beginning to be developed and offer the lowest impact form of packaging, as they are using a renewable source material, reducing waste, however, they are not widely available yet or economically viable as the systems and infrastructure to collect and manufacture these agro-waste products into bio-plastic are not there yet.

Different types of bio-plastics

Both plant-based and oil based plastics can be non-biodegradable or biodegradable, which means they break down over time.

- Oxo-degradable – a fossil-fuel based plastic with an added chemical which makes it break down into tiny particles (i.e. microplastics) in the presence of light and oxygen. However, the plastic particles persist in the environment which only further exacerbate the negative environmental impacts of plastic pollution. For this reason Oxo-degradable plastic has been identified by the UK Plastics Pact as one of the eight “problematic” plastics to be eliminated by 2025.

- Boithene – an oxo-biodegradable plastic, like polythene, with an added chemical to break it up, as above, over time in the presence of light and oxygen. As above, this is a damaging form of polythene as it releases tiny harmful plastic particles into the environment and therefore should be avoided.

17 https://www.wrap.org.uk/sites/files/wrap/Understanding%20plastic%20packaging%20FINAL.pdf

18 https://www.researchgate.net/publication/315515977_Biopolymer_production_and_end_of_life_comparisons_using_life_cycle_assessment

- Bio-sourced plastic – e.g. Bio-PE, PLA, bio-PET

These are plastics that contain some raw material from renewable plant-based sources – mainly corn or sugar cane based.

Most of these bio-sourced bio-plastics are not biodegradable nor home-compostable (bio-PE, bio-PET) or are fit only for industrial composting (PLA)

- Bio-ethylene – Bio-PET, Bio-HDPE, and Bio-LDPE
  plant-based version of polythene made from sugar – this is potentially a suitable alternative, depending on the raw materials used and origin of the sugar.

Ability to protect and preserve food

Properties of certain bioplastics like thermal instability, difficult heat saleability, brittleness, low melt strength, high water vapour, oxygen permeability, vulnerability to degradation and limited long-term stability and poor mechanical properties are factors which restrict their applications in food packaging[19].
Trials of compostible and bio-plastic bags for storing fresh food have found that the bags suck moisture out of the food, causing it to wilt or dry up, significantly shortening shelf life. This suggests these types of plastic are only suitable for short term transportation of food, such as to be used as a carrier bag rather than a food packet.

End of life

All these options require light and oxygen to break down. If they end up in landfill they won't break down. None of these plastics are compostable aside from bio-PET, and this can only be composted in very high heat controlled industrial composting, which is currently not available in the UK.

A recent study into different compostible and bio-plastics found a lack of clear evidence that biodegradable, oxo-biodegradable and compostable materials offered an environmental advantage over conventional plastics, and the potential for fragmentation into microplastics caused additional concern[20].

It also complicates waste management where separate collecting of sorting of these different materials is needed to ensure they are each disposed of appropriately.

North London Waste Authority explained how they currently deal with bio-plastics:
“The corn starch / bioplastic containers are not recyclable at the facilities we use in North London, as they are not easily distinguishable from similar products made from other materials. If they go through the materials recovery facility (MRF) they are not able to be recycled through the processes used there and at the composting and Anaerobic Digestion facilities we use, they will be screened out as packaging and disposed of as waste. The only reliable way of treating them at the moment is through home composting facilities.”

Bio-plastics from food waste

Bio-plastics that are made from food waste are beginning to be developed. PHA (polyhydroxyalkanoate) is one such bio-plastic which could provide the perfect solution, being made from agro-industrial waste, providing an effective barrier for food preservation and being fully biodegradable. So it is solving two issues at once – food waste and packaging waste.

Most raw materials used in the PHA industry are food crops, sugarcane, surplus whey from the

19 https://www.tandfonline.com/doi/full/10.1080/23311932.2015.1117749
20 https://pubs.acs.org/doi/pdf/10.1021/acs.est.8b06984

dairy industry and vegetable oil. The unique properties of PHA are recognized as better oxygen barrier (than both non-biodegradable polypropylene (PP) and polyethylene terephthalate), better water vapor barrier (than PP), and the fat/odour barrier. PHA effectively biodegrades in both aerobic and anaerobic environments.

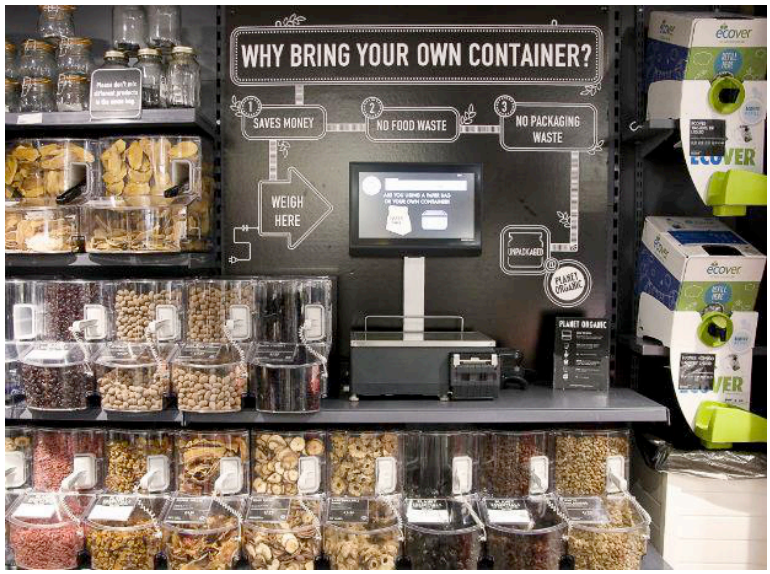
However, the manufacturing process is not yet efficient enough to make this material widely available. The current industrial expense for PHA production is 5–10 times higher than that of petroleum-derived polymers[21].

Bio-plastics: conclusion

Bio-ethylene and bio-sourced plastic are promising, as they contain the most natural/renewable materials and are fully biodegradable into an inert substance, under certain conditions. The LCA of a bio/plant-based plastic is generally lower than its petrochemical-based equivalent[22]. However, the biodegradable nature of bio-plastics varies greatly, and it's ability to preserve food is inferior to plastic. Furthermore, until waste management adapts to be able to recycle or compost bio-plastics, and more sustainable raw materials, such as agri-industrial food waste, are made more widely available, bio-plastics don't offer any environmental advantage over plastic.

4. Towards a zero-waste circular economy

Moving away from single use



Every packaging option requires a compromise – which ever packaging is used, there will be an environmental cost, either at the raw materials stage, production, transportation and eventual disposal. The ideal option for all packaging options is for them to be reused as much as possible. Zero-waste stores are beginning to gain momentum, but are not widely available nor has the idea gone mainstream. However in the last year, some retailers like Waitrose, M&S and Asda have trailled refill stations in selected stores to assess their viability. It is worth keeping an eye on these trials to see if they have traction with customers and are scalable.

Refill stores require a behaviour change for customers to plan ahead, being prepared with a collection of bags and containers to hand at point of purchase. This is incongruous with on-the-go snack food positioning. However, there may come a time when this becomes the norm. Until then, a switch to a Tooty Fruity refill station in stores across the UK would require the provision of paper or plastic bags for the customer to use if they haven't brought their own container. This could be trialled in a few stores initially to assess the efficacy and impact on sales. Branded recycled paper bags could be provided for customers who don't have their own receptacle.

21 https://www.sciencedirect.com/science/article/pii/S0160412019301357

22 https://www.researchgate.net/publication/315515977_Biopolymer_production_and_end_of_life_comparisons_using_life_cycle_assessment

5. Conclusion

There is a strong case for Tooty Fruity to continue to use the same packaging. The food packaging landscape is extremely complex with many factors to take into account – long supply chains, gaps in recycling infrastructure and public awareness/behaviour, a multiplicity of different materials and packaging options which will be dealt with differently in different regions mean that it can be very hard to be precise when assessing specific packaging options. But some general rules apply:

Environmental impacts will generally be lower where:

- Transport is kept to a minimum (before, during and after manufacture)
- Any plant-based materials involved are grown using organic rather than industrial farming methods or made from agricultural waste products
- Reuse of the item is maximised
- The manufacturing process uses renewable/clean energy sources
- Land use change does not involve the destruction of old growth forests (highest impact), FSC style forests, peatland, etc
- The item is either recycled or composted rather than disposed of in landfill or incinerated
- A recycled product will have a lower LCA than its equivalent made from virgin feedstock (plant or petrochemical based).
- For all plastics, recycling generates the lowest emissions at end of life[23].
- And it is generally better in LCA terms to recycle a product than to compost it.

6. Recommendations

a) Continue using the PET trays, while staying abreast of latest developments.

The new plastics economy – working across sectors towards a circular economy for plastic around the world

The UK Plastics Pact

b) Keep an eye on the development of PHA bio-plastic made from food waste.

c) Monitor refill station trials in supermarkets

23 https://www.wrap.org.uk/sites/files/wrap/Understanding%20plastic%20packaging%20FINAL.pdf