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Compostable biopolymer use in the real world: Stakeholder interviews to better understand the motivations and realities of use and disposal in the US

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ABSTRACT

The use of compostable biopolymers in the United States has grown over the past decade and is predicted to continue to grow over the coming years. Though many studies have been done to assess biopolymer environmental impacts, few have explored how they are actually being used and disposed of by consumers. Only with a thorough understanding of real world use will environmental assessments be able to provide meaningful results that can inform best practices for municipal waste management. This paper identifies and explores where consumers are most likely to come into contact with compostable biopolymers, actual disposal methods, and the motivation behind compostable biopolymer use and disposal. To assess where compostable biopolymers are being used, audits of local grocery stores were conducted, as well as semi-structured interviews with compostable biopolymer users in four different food service categories (cafeterias, catering companies, limited food service establishments, and recreational concessions) were completed. Findings suggest that consumers are most likely coming into contact with compostable biopolymers in a commercial food service setting. The decision to purchase compostable biopolymers was based on a variety of factors, such as their perceived sustainability, but was not directly tied to the ability to compost them. One of the clearest distinctions between those who were able to compost biopolymers and those who sent these products to landfill was the type of sustainability goals each organization set. Measurable waste to landfill goals resulted in biopolymers being sent to compost facilities, in contrast to an amorphous goal to be sustainable, which was connected to biopolymers being sent to landfill. Yet for all food service categories, disposal decisions relied heavily on the regional waste infrastructure that was available.

1. Introduction

Over the past five decades the use of plastic has become ubiquitous. Plastics are regularly used in the manufacturing of many products, from grocery bags to synthetic lumber, and from toothbrushes to sutures. Over 15,000 plastics manufacturers operate in the U.S. with facilities located in every state. The value of shipped plastic goods in the U.S. was over $373 billion, and the plastics industry is ranked as the third largest sector of U.S. manufacturing (Carteaux, 2013). In addition, plastics make up approximately 13% of the country's municipal solid waste stream, which is roughly equivalent to 32 million tons of plastic waste generated annually (USEPA, 2012).

Biopolymers are one of the fastest growing segments within the global plastics market. Biopolymers (or bioplastics) are plastics that can be produced from renewable materials, including sugar, corn, soy, hemp and captured methane from waste. Biopolymers do not have to be made entirely out of renewable materials, as many produced today are blends of conventional and renewable feedstocks (Hartmann, 1998; Shen et al., 2009, 2010). Furthermore, some biopolymers such as Bio-PET have an identical polymeric structure as their conventional counterpart and can be recycled along with fossil-based plastics of the same resin. With such a variety of feedstocks and manufacturing processes not all biopolymers are biodegradable or compostable (Lopez et al., 2012; Roland-Holst et al., 2013; Hottle et al., 2013). Worldwide consumption of all biopolymers including compostable and non-compostable plastics in 2012 reached 981,056 t (less than 1% of total polymer consumption), and the market is expected to continue to grow in the United States (USDA, 2008) and globally (Shen et al., 2009; Rapra, 2012). The growth of the biodegradable and compostable subset of

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biopolymers is predicted at a rate of around 13% annually (Platt, 2006). Of total global biopolymer production, 43% are biodegradable plastics including compostable polymers (EuBP, 2014a,b).

Compostable plastics must be able to degrade in a commercial composting setting according to set American Society of Testing and Materials (ASTM) standards including ASTM D6400-04 Standard Specification for Compostable Plastics, ASTM D6868-03 Standard Specification for Biodegradable Plastics Used as Coatings on Paper and Other Compostable Substrates, and ASTM D5338-98(2003) Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions (ASTM, 2003a,b, 2004; Song et al., 2009). Of compostable plastics, polylactic acid (PLA) is the most abundant, but thermoplastic starch (TPS) and polyhydroxyalkanoates (PHA) are also common (Tabone et al., 2010; EuBP, 2014a,b). Biodegradable plastics still degrade but do not conform to the timeframe in which commercial composting occurs and have a different set of ASTM standards (Kale et al., 2007). This biodegradable technology is used in products like grocery bags, trash bags, packaging, diapers, and agricultural mulch films (Ammala et al., 2011). It is important to note that while ASTM standards are an important industry codification, many commercial compost facilities are struggling to process them; this issue is discussed in more detail below.

The drivers behind the growth of compostable biopolymers vary across regions, often relating to bans on conventional plastics, bio-preferred purchasing, and zero waste initiatives. According to the literature these drivers are associated with concern over increased fossil fuel use, greenhouse gas emissions, plastics pollution, decrease in landfill space, and human health (Ren, 2003; Kijchavengkul and Auras, 2008; Gironi and Piemonte, 2011; Álvarez-Chávez et al., 2012; Gómez and Michel, 2013). For example, there are many conventional plastic bans being implemented and compostable product mandates being established. Recently the State of California has banned single use plastic bags (Steinmetz, 2014), and it is estimated that over 100 U.S. cities have banned poly(styrene) (PS) food and beverage containers (Goldstein, 2013). The U.S. federal government's BioPreferred Program mandates federal bio-based product purchasing, and it is likely that it has inspired cities across the U.S. to implement similar programs. After speaking with a city representative, it is clear that the City of Phoenix is one example of this (Carsberg, 2014). Organizations in every state are either voluntarily adopting or mandated to create waste to landfill reduction plans. Additionally, growth in the composting industry and new organics waste diversion policies, such as the newly passed legislation in both California and Massachusetts, which requires all commercial organic wastes be diverted from landfill, will continue to encourage waste to landfill reduction goals (Yepsen, 2009; BioCycle, 2014; EEA, 2014).

Though compostable biopolymer use is growing in response to the aforementioned trends, there have also been well documented challenges and concerns related to their use. The U.S. Composting Council has identified five key challenges which include: labeling & identification, enforcement & legislation, ASTM standards, consumer education, and impacts to the National Organics Program (California Organics Recycling Council, 2011). Clear labeling or demarcation of compostable bioplastics is crucial for helping consumers (here consumers are defined as individuals who are using compostable biopolymer products, in either a residential or commercial setting) accurately identify and separate their waste in the right disposal bins. Enforcement and legislative challenges refer to the lack of federal regulations for labeling products compostable, biodegradable, or biobased. Without enforcement regarding the use of these labels, some companies may mistakenly market products as compostable when they are not. In addition, some products that have been designed to meet ASTM compostability standards still are not degrading adequately compared to other organic wastes (Ghorpade et al., 2001; Mohee and Unmar, 2007; Gómez and Michel, 2013; Hottle et al., 2015b). The reasons for this are varied, but one may be that some ASTM standards include decomposition times that are longer than actual commercial composting timeframes. For example, a variety of ASTM certified compostable biopolymers take over three months to decompose in a commercial compost facility and one of the largest composters in the Pacific Northwest States they have a ninety day turn around time for creating finished compost (Worldcentric, 2014; CedarGrove, 2015). The challenges associated with consumer education are many as there is profound misunderstanding between the terms biodegradable, compostable, bio-based, as so forth. Moreover, many consumers and compostable biopolymer users do not have a general knowledge of the differences in composting and landfilling compostable plastics. Lastly, compost that has been made with compostable bio-plastic feedstock has caused problems for organic growers as there has been debate over whether compost made with these products violates USDA Organics label rules and regulations (California Organics Recycling Council, 2011).

In addition to these challenges, there has been concern over which disposal method is ideal for compostables (Weiss et al., 2012; Yates and Barlow, 2013; Rossi et al., 2015), the use of GMO feedstocks for bioplastics (Gerngross and Slater, 2000; van Beilen and Poirier, 2007; Snell et al., 2015), and possible impacts to human health (Roes and Patel, 2007; Thompson et al., 2009; Álvarez-Chávez et al., 2012). Research around compostable bioplastics is ongoing, and many stakeholders who currently handle these products are also trying to determine best practices. For example, cities now working to divert more waste from landfill are grappling with many of the aforementioned challenges. Trying to weigh the potential costs and benefits to determine the overall sustainability of these products has become an important task for many managers, purchasers, and policy makers.

To help inform decision makers, various tools have been developed to accurately assess what the impacts of different plastics products may be. Over the past decade there has been a proliferation of life cycle assessments for biopolymers but the assumptions that underpin assessment can drastically affect overall findings (Hottle et al., 2013). To date many environmental assessments of biopolymers have been done, including inventory improvements for life cycle assessments (Vink et al., 2010; Hermann et al., 2011) but few life cycle assessments adequately address end of life and findings vary widely (Shen and Patel, 2008; Weiss et al., 2012; Hottle et al., 2013; Koller et al., 2013; Yates and Barlow, 2013). Moreover, gaps exist in the available literature which document how compostable biopolymers are being used and their exact method of disposal. This US-based study provides information on where compostable biopolymers are most commonly found, who is using them, and how organizations using these products are actually disposing of them. In addition, the study evaluates the motivations behind purchase and disposal decisions. Our overall intent is to provide understanding for how these products are being used so that assessments are not limited by wide ranging assumptions and can produce more meaningful results.

Through stakeholder and user interviews, this paper identifies where compostable plastics are being used and disposed, and the motivation behind purchasing and disposal decisions. Stakeholders include producers and distributors in the compostable biopolymer industry, compostable biopolymer experts, and decision makers who currently manage these products like municipal solid waste professionals or commercial composters. Users include organizations that use compostable biopolymers, such as cafes, cafeterias, and recreational concessions. The findings from these interviews provide insight into how these products are now being managed and in doing so we hope to contribute key information