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Table of Contents

Table of Contents	2
1. Executive Publishable Summary.....	3
2. Introduction	8
2.1 About RoadToBio.....	8
2.2 Goal and scope of this report	8
3. Materials and Methods	8
3.1 Selection of resources.....	8
3.2 Analysis	10
4. Results	10
4.1 Awareness and Knowledge.....	11
4.2 Associations and Connotations	12
4.3 Consumption Decision and Willingness to Pay.....	14
4.4 Information and Labels.....	17
4.5 Barriers	18
5. Discussion	22
5.1 Comparability of results of evaluated studies	22
5.2 Sample representativeness of evaluated studies	22
5.3 Identification of gaps evaluated in studies	22
6. Overarching insights.....	23
6.1 Awareness and Knowledge.....	23
6.2 Associations & Connotations.....	24
6.3 Consumption decision and WTP	24
6.4 Information and labels.....	24
7. References	25
Annex I: Details on evaluated publications	27

1. Executive Publishable Summary

This report was prepared within the context of RoadToBio, which is an EU-funded project in the Horizon 2020 research and innovation programme that aims to pave the way for the European chemical industry towards a higher bio-based portfolio and competitive success based on the benefits offered by the bioeconomy. The project will deliver a roadmap for the chemical industry that will specify benefits as well as barriers towards a bio-based economy to meet the societal needs in 2030.

The goal of this study is to compile, compare and analyse currently existing research and reports about public perception of bio-based products in order to identify barriers for further market development. Various studies have analysed citizens' ideas about a future bioeconomy, public engagement and public perception. Ideas about the bioeconomy, including long-term wishes and worries of citizens, can potentially influence public perception. However, as overall awareness of bio-based products seems to be quite low, according to most of the reviewed research, this influence is very limited. Engaging with civil society may increase people's awareness of bio-based products and increase public acceptance for a transition to a bio-based society (Davies et al. 2016). The perception of a product influences consumers' attitudes towards it, and in turn a positive attitude stimulates the decision to buy a product (Meeusen et al. 2015). In this study, we focus on results of analyses of public perception, since this is most influential on successful market development. The literature included in this study mainly focuses on market perception, and especially consumers. The research in RoadToBio focuses on consumer perception, referring to the awareness and attitudes of consumers towards bio-based products and their willingness to buy them.

Project deliverables and scientific literature on the topic at hand were collected from EU projects, national projects, and through a search on Science Direct (search terms: "public perception" AND "bio-based"). The resources were analysed with a view on relevance, choosing studies that analysed the perception of citizens or consumers regarding bio-based products. Excluded were studies focusing on bioenergy/biofuels, studies that described tools for engagement but did not actually analyse levels of awareness etc., studies dealing with product that included bio-based packaging, but did not put a focus on the 'bio-based' part. Studies dealing with perception of biotechnology present a special case and were thus included, but addressed separately in order to enable a modicum of comparability of results. In total, 17 studies dating from 2009 to 2017 were included in our analysis, one of which on biotechnology as stated above.

The analysis revealed four general common themes that were each addressed by several publications: awareness and knowledge, associations and connotations, consumption decision and willingness to pay, information and labels. It needs to be kept in mind that the researched studies were carried out with different methodologies on different target groups. Comparability of results is therefore limited. The results presented in this report should be

understood as a review of trends and most important issues and not as a holistic and conclusive analysis.

Awareness and knowledge

The results show that the awareness of the existence of bio-based products seems to lie around 50%. While there is a general understanding of what bio-based products are among this consumer group, specific knowledge about product characteristics is mostly missing and misconceptions occur. The relatively low level of awareness can be a barrier for further market development of bio-based products, if the fact that they are bio-based is to be the unique selling point. In some cases, producers might want to market their products as bio-based, in others, they may choose to simply advertise a lower price or better properties. Awareness is especially important in the first case. This is similar for knowledge: if consumers are to be convinced to buy bio-based products, a low level of knowledge about advantages of bio-based products can be counterproductive. However, it is questionable whether this can be solved on a general level – bio-based products have very different properties and impacts, and general knowledge may not be helpful or convincing to consumers, if they do not receive specific information about the bio-based product in question.

Associations and connotations

Consumers link various associations and connotations with bio-based products. Associations are related to environmental aspects, personal benefits and product properties. Various studies show people assume that bio-based production is aimed at finding environmentally friendlier solutions. This results in a positive attitude towards bio-based products, but also brings with it the problem of high expectations towards them. Furthermore, some common misconceptions are prevailing, such as the assumed link between bio-based and organic products or the assumptions that bio-based products are biodegradable or recyclable. These high expectations and misconceptions bring with it the danger of disappointment, and consequentially a negative consumption decision, if bio-based products do not possess the expected characteristics.

There appear to be as many positive as negative connotations about bio-based products. The negative connotations in themselves could prove barriers for further market development. It stands out that on both the positive and the negative side, many are related to the impact on the environment and refer to a global scale. The factual environmental impact of a bio-based product could thus prove to be a very important aspect in the final attitude of consumers. A difference in scale was noticed for economic connotations: positive connotations are related to rather global advantages, while negative ones are on a personal scale. As Meeusen et al. (2015), Lynch et al. (2017) and Rumm et al. (2013) pointed out that personal benefits are most influential on perception and consumption decision, these negative connotations could be especially disadvantageous. While expected health benefits

and innovativeness of bio-based products are valued positively, participants do not seem to trust bio-based producers completely regarding their claims and are concerned about ethical issues.

Buying decision and willingness to pay

The results show that around two thirds of participants state to prefer bio-based products over conventional products (given no other restrains, like a difference in price), but only 12% have ever consciously chosen bio-based products over conventional ones. On the one hand, this could be related to limited availability. On the other hand, it shows that the consumer pool that actively chooses bio-based products is small, but has potential to grow. Analysing the motives of consumers more closely shows that consumers generally drawn to environmentally friendly products also have a more positive attitude towards bio-based products and are willing to pay more for them. Most consumers, however, are relatively unaffected by the fact that a product is bio-based. It counts as an additional benefit, but personal benefits are far more important in the consumption decision. This shows that the fact that a product is bio-based is only of real importance to a niche market.

Finally, participants mentioned a range of personal benefits influencing their decision to buy a product, considering that personal benefits were not mentioned when consumers were asked to mention connotations. It illustrates the importance to focus communication on personal benefits (potentially communicated through a label, as mentioned by Rumm et al. (2013)).

Willingness to Pay is a relevant issue for public acceptance only in those cases where bio-based products will be more expensive and the higher price is not compensated by better product functionalities. Moreover, the fact that a product is bio-based is only one aspect among many others that influence buying decisions. The results –mainly of theoretical studies– show that a significant percentage of participants (between 55% and 64%) would be willing to pay a little bit more for a bio-based product than for a conventional product, mainly if the benefits of the resource base are clear to them.

Information and labels

Most participants thought that information on the benefits of bio-based products is not readily available. Participants even mentioned the lack of information on these benefits as a barrier for not consuming more bio-based products. This need for differentiated information, however, is contradictory to the need for simplicity stated in other contexts.

Labels were mentioned as being more effective to present detailed information than textual information. A multitude of ecolabels exists in Europe, but few of them are specific enough for most bio-based products. There is no ecolabel that was developed purposely for bio-based products. Creating such a label would be a costly exercise, after which it may take a very long time before a label is known to consumers, if ever. It seems doubtful that those

labels focussing specifically on the fact that a product is bio-based (these do exist, without a focus on environmental aspects) would be convincing for a general public, since many participants were not convinced purely by the fact that a product was bio-based. It is seen merely as an added value next to other product properties and impacts.

When presented mock-ups of self-developed labels, participants preferred information directly on a product label over the possibility to search for further details on the internet¹ (Rumm et al. 2013). The label should give information about altruistic motives like environmental protection or resource conservation, and about the origin of the raw materials. The term “renewable resources” is preferred above “bio-based” and the term “sustainability” should be avoided.

Finally, attributes that are of personal benefit for the consumer should be advertised.

Conclusion

Considering the limited comparability of the studies, the report draws tentative conclusions for communication and interaction with consumers for producers of bio-based products. Due to limited awareness and knowledge, when communicating about bio-based products, it seems best to go for one of two options. Option A: informing the consumer that the product is bio-based, and providing information what impacts this has (in comparison to conventional processes). Option B: inform the consumer that the product is better and nice to have, using other arguments while not mentioning bio-based at all.

It would appear difficult to overcome the multiple negative connotations (related to environment, economics, trust and ethics) with a single instrument. Instead, a diversified approach focussing on multiple aspects would be needed.

General misconceptions and valid concerns can be removed or addressed, on the one hand through education and, on the other hand, through promotional and public relations activities of the industry. The positive connotations described above could provide inspiration, for example consumers’ preference for regional or local production and waste reduction etc.

Environmental connotations may be addressed through informing the consumer about the results of a life cycle assessment (LCA). This has to be carried out at the product level, making this an expensive instrument.

Valid concerns about product quality require an improvement of the product quality. Lack of trust could be tackled through product branding. Regarding buying decisions and willingness to pay, it seems that if a brand owner or retailer is not prepared to focus on a niche market, he should focus on the personal benefits that bio-based products bring (potentially

¹ This could for example be done through a barcode-scanner app similar to CodeCheck (www.codecheck.info), a platform that provides independent information about food and cosmetics ingredients to the customer in a user-friendly way.

communicated through a label) and be aware that most consumers are only willing to pay little or no more for bio-based products.

In some cases, it may be determined or perceived that the consumer is unwilling to pay the green premium for a bio-based product of equal quality. In other words: no higher price can be charged for the bio-based product. In this case brand owners of consumer products may take the initiative that actors along the value chain carry the burden and absorb the higher product costs. This strategy has been applied in the recent past by brands such as Coca-Cola and IKEA. It allows brands to focus on image and branding, looking at the problem from a different perspective.

Finally, a product being bio-based is just part of the story. Telling the story works better with a label than with a text. A label presenting information about the product must not be a label for bio-based, but tell the entire story. The label should give information about the attributes that are of personal benefit for the consumer, about altruistic motives like environmental protection or resource conservation, and about the origin of the raw materials.

It is contradictory, and therefore a challenge, that consumers indicate they want to be informed, but when it comes to putting effort in to informing themselves, this switches to easily available information, such as a (“simple”) label.

2. Introduction

2.1 About RoadToBio

This report was prepared within the context of RoadToBio, which is an EU-funded project in the Horizon 2020 research and innovation programme that aims to pave the way for the European chemical industry towards a higher bio-based portfolio and competitive success based on the benefits offered by the bioeconomy. The project will deliver a roadmap for the chemical industry that will specify benefits as well as barriers towards a bio-based economy to meet the societal needs in 2030.

The roadmap developed in RoadToBio will contain two main components: first, an analysis of the most promising opportunities ('sweet spots') for the chemical industry to increase its bio-based portfolio as well as the technological and commercial barriers and the hurdles in regulations and acceptance by society, governing bodies and the industry itself, and second, a strategy, action plan and engagement guide to overcome the existing and anticipated barriers and hurdles as mentioned above.

2.2 Goal and scope of this report

The visibility of bio-based products in the market and their perception by the public is key to a successful market development of these materials. The goal of this study is to compile, compare and analyse currently existing research and reports about public perception of bio-based products in order to identify barriers for further market development. Various studies have analysed citizens' ideas about a future bioeconomy, public engagement and public perception. Ideas about the bioeconomy, including long-term wishes and worries of citizens, can influence public perception. In this study, we focus on results of analyses of public perception, since this is most influential on successful market development. The literature included in this study mainly focuses on market perception, and especially consumers. We focus on consumer perception, referring to the awareness and attitudes of consumers towards bio-based products and their willingness to buy them.

3. Materials and Methods

3.1 Selection of resources

First, we gathered relevant reports, project deliverables and scientific literature on public perception of bio-based products. We collected resources from EU projects, national projects, and conducted a search on Science Direct (search terms: "public perception" AND "bio-based"). We analysed the resources with a view on relevance, choosing studies that analysed the perception of citizens or consumers regarding bio-based products. We

excluded studies focussing on biofuels or bioenergy². Studies discussing the importance of public engagement or describing tools for engagement but not analysing actual perception were not considered³. Studies regarding products with bio-based packaging, that only concerned the perception of the product itself, not the packaging specifically, were also excluded⁴. Studies addressing perception of biotechnology usually focus on the technologies applied, and only partly on the products. Furthermore, products produced with biotechnology are not necessarily bio-based, since their resource base may be non-biogenic. Nevertheless, biotechnology is an important enabling technology for bio-based products and products made via biotechnological processes belong to the bioeconomy according to the EU definition. Consequently, perception of biotechnology may present a barrier for their market development. We therefore included a study exploring the public perception of biotechnology, but treated it separately during analysis.

In total, 17 studies dating from 2009 to 2017 were included in our analysis, one of which on biotechnology as stated above. The publication years of the other 16 are shown in **Figure 1**. In the last 5 years, the number of studies about public perception has increased in comparison to the years before, and no studies prior to 2009 were found. Most publications describe the results of quantitative studies on public perception, applying, for example, consumer surveys or choice experiments. Some studies were qualitative in nature, for example using focus groups or experimental auction methods. An overview and details on all publications included in this study, including the sample area, sample size and sample representativeness can be found in Annex I.

² For example Cacciatore MA, Scheufele DA, Shaw BR (2012) Labeling renewable energies: How the language surrounding biofuels can influence its public acceptance. *Energy Policy* 51:673-682

³ For example results of the BioSTEP project, <http://www.bio-step.eu/>

⁴ For example Almenar E, Samsudin H, Auras R, Harte J (2010) Consumer acceptance of fresh blueberries in bio-based packages. *Journal of the Science of Food and Agriculture* 90(7):1121-1128

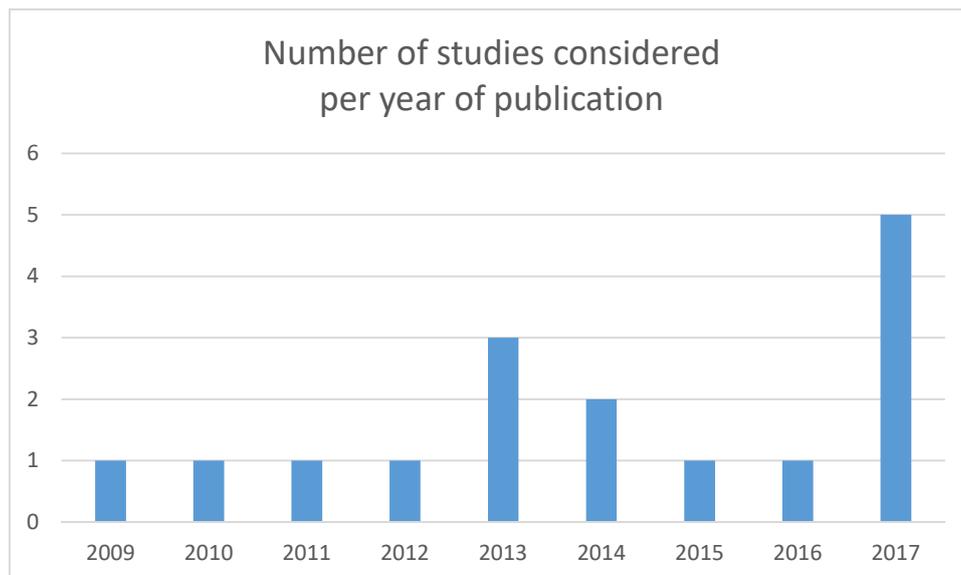


Figure 1: Number of studies considered for analysis plotted per year of publication.

3.2 Analysis

To compare these publications and analyse their findings, we conducted a meta-study, using qualitative data assessment (QDA) software. This enabled us to approach the material in a systematic way, identifying common themes and filtering out relevant results. As a first step, we identified the different aspects that each study analysed. Then, we combined these aspects in common themes between the different studies. Finally, we examined the results regarding these themes across all sources and compared them to one another. The results are described below. It should be mentioned that due to very divergent methodologies of the studies, comparability of results is limited. Our aim is to highlight trends and general developments, as well as differences in results.

4. Results

The analysis revealed four general common themes that were each addressed by several publications: (1) awareness and knowledge, (2) associations and connotations, (3) consumption decision and willingness to pay, (4) information and labels. The results for each of the themes are described below. Finally some barriers for further market development of bio-based products that were mentioned directly or indirectly by the studies, including barriers resulting from public perception of biotechnology, are described.

4.1 Awareness and Knowledge

The first common theme discovered in multiple studies is the analysis of awareness and knowledge of participants about bio-based products. Some studies made general observations about the relatively low level of awareness, others quantified aspects such as familiarity and knowledge. The level of familiarity with bio-based products was mostly analysed through self-assessment of the participants, while their specific factual knowledge was mostly tested by researchers. The most important observations across the different studies are summarized below.

Five studies quantified the level of awareness of their respondents with bio-based products. **Figure 2** shows that all studies found a similar range of participants who had heard about bio-based products prior to the study. One study asked about bio-based products in general (Meeusen et al. 2015), the others about the specific bio-based products addressed in the study (i.e. bioplastics (Veldkamp 2013; Kainz 2016; Blesin and Klein 2017) and wood polymer composites (Osburg et al. 2013)). These results show that overall awareness of bio-based products lies around 50%. Four of these studies additionally analysed the familiarity with bio-based products, quantifying how many people stated to know well what the bio-based products in question were. The results are very divergent, which is especially striking in the cases of the lowest and highest value (7 and 32%, respectively), since they both addressed bioplastics. A cause for this difference could be the way in which the question was posed, the answers were bundled or the composition of the sample. The second highest value reported by Meeusen et al. (2015) represents an average over 7 countries, with values ranging from 5.8% in the Netherlands to 40.9% in Italy. This shows that there are great regional differences to be taken into account.

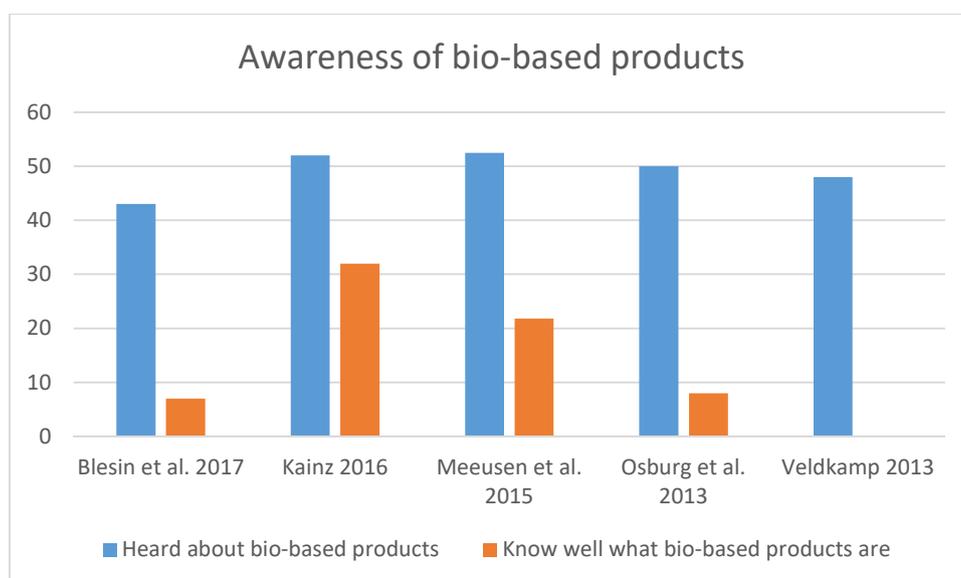


Figure 2: Awareness of bio-based products: Percentage of respondents that have heard about bio-based products before the study (blue) and state to know well what bio-based products are (orange).

Next to the awareness of participants, some studies analysed the knowledge about bio-based products. Two studies assessed the self-estimated knowledge level of participants. Kainz (2016) found that one third of participants rated their level of knowledge to be fair or high and similar numbers are described by Karachaliou et al. (2017), with 36.2% of participants estimating their knowledge to be at least sufficient. Six studies tested the knowledge of their participants, for example asking questions ranging from easy to difficult, and comparing the level of wrong, correct, and "I don't know" answers. Karachaliou et al. (2017) found that recognition of bio-based products was reasonably well for many product categories. However, many participants incorrectly associate "bio-based" with organic products, stemming from the fact that in some languages "bio" is also used to describe products from organic agriculture. While stating that the largest part of participants had an average knowledge about bio-based products, Kurka (2012) conclude that this reflected some basic understanding but little specific knowledge about characteristics of bio-based products. Similarly, Kainz (2016) describes that participants had a rather one-sided knowledge about bio-based products, mainly stating the resource base and the assumption of biodegradability. Blesin and Klein (2017) found that there were generally more "I don't know" and wrong answers than correct ones. Among the participants who said they knew well what bio-based products are, knowledge was indeed better than other groups, but still most questions were not answered correctly. Finally, Kurka and Menrad (2009) and Lynch et al. (2017) report a rather low knowledge about bio-based products in most EU countries.

Overall, it stands out that awareness of the existence of bio-based products seems to lie around 50% and that while there is a general understanding of what bio-based products are among these people, specific knowledge about product characteristics is missing and misconceptions occur.

4.2 Associations and Connotations

The second common theme described in the studies are associations and connotations that participants expressed regarding bio-based products. In this context, associations mean neutral impressions of participants about bio-based products,, while connotations are valued as positive or negative aspects of bio-based products. In most studies, associations were assessed freely, allowing participants to name what they associated with bio-based products based on prior knowledge. Connotations were sometimes assessed freely and sometimes with guided exercises, where participants had, for example, to value pre-determined statements.

Table 1: Associations with bio-based products

Association with bio-based products	Sources
Made from renewable resources	Veldkamp 2013; Kainz 2016; Blesin and Klein 2017
Biodegradable	Kainz 2016; Blesin and Klein 2017
Environmentally friendly or	Veldkamp 2013; Meeusen et al. 2015; Kainz 2016;

sustainable	Blesin and Klein 2017; Karachaliou et al. 2017
Possibility for recycling	Veldkamp 2013; Meeusen et al. 2015; Kainz 2016; Blesin and Klein 2017
Bio-based is also organic	Rumm et al. 2013; Veldkamp 2013; Meeusen et al. 2015; Blesin and Klein 2017; Karachaliou et al. 2017
Lower carbon footprint	Kainz 2016; Karachaliou et al. 2017
Health	Veldkamp 2013; Meeusen et al. 2015
Safe to use	Karachaliou et al. 2017; Meeusen et al. 2015

Associations that were found in at least two studies are shown in **Table 1**. The associations are a mixture of associated product properties (e.g. biodegradable, recyclable, organic), environmental statements (e.g. renewable resources, biodegradable, environmentally friendly, lower carbon footprint) and personal benefits (e.g. health, safe to use). It stands out that most aspects are more or less directly related to the environment.

Furthermore, the list contains some common misconceptions, such as the assumption that bio-based products are also organic and that bio-based products are biodegradable or recyclable. Meeusen et al. (2015) conclude that on a product specific level, personal benefits of bio-based products are more relevant for participants' perception than technical aspects. Environmental friendliness and healthiness, for example, relate to personal benefits, such as personal motives and having a sustainable and healthy lifestyle. Participants generally did not associate bio-based products with technical innovation.

Various studies show that people assume that bio-based production is aimed at finding environmentally friendlier solutions. This results in a positive attitude towards bio-based products, but also brings with it the problem of high expectations towards them.

Table 2: Positive and negative connotations about bio-based products. Based on Kurka and Menrad 2009; Meeusen et al. 2015; Kainz 2016; Blesin and Klein 2017; Karachaliou et al. 2017; Lynch et al. 2017

Positive connotations	Negative connotations
Environment <ul style="list-style-type: none"> • Environmentally friendly • Sustainable • Natural • Waste reduction • Reduced dependence on non-renewables • Climate friendly • Renewable • Compostable 	Environment <ul style="list-style-type: none"> • Slow biodegradation • Agricultural pollution • Land use • Deforestation • Monocultures • Uncertain environmental impacts
Economy <ul style="list-style-type: none"> • Economic growth • Regionally produced • Agricultural development 	Economy <ul style="list-style-type: none"> • Expensive • Limited availability • Product quality
Health <ul style="list-style-type: none"> • Healthy • Safe 	Trust <ul style="list-style-type: none"> • Misleading • Greenwashing

	<ul style="list-style-type: none"> • Buzzword • Marketing item
Innovation <ul style="list-style-type: none"> • Innovative • Useful 	Ethics <ul style="list-style-type: none"> • Competition with food • Genetic modification

Positive and negative connotations with bio-based products can be clustered in four categories each, which differ slightly from each other: Positive connotations concern environment, economy, health and innovation, while negative connotations can be clustered into environment, economy, trust and ethics-related topics. While for environmental aspects, both the positive and negative connotations regard the same scale, and are all rather global and altruistic, the economic connotations differ in scale: advantages are seen on a larger scale, such as for economic growth and agricultural production, while disadvantages mostly concern the personal scale, such as higher prices and limited availability. Expected health benefits and innovativeness of bio-based products are valued positively. Participants do not seem to trust bio-based producers completely regarding their claims: they suspect that consumers are being misled and can become victims of greenwashing. Furthermore, two ethical issues are named: a suspected competition with food production and dangers of genetic modification.

4.3 Consumption Decision and Willingness to Pay

Various studies analysed whether participants would consider buying bio-based products, what would influence their consumption decision and their willingness to pay for them. The results summarized in the following were gathered with various methods, including asking for statements convincing or discouraging the decision to buy bio-based products, choice experiments, and inquiring about the importance of attributes when making a consumption decision.

Asking about participants preference for bio-based and conventional products, Karachaliou et al. (2017) report that 66.6% of participants would prefer bio-based products over non-bio-based products if available, while 25.9% answered "I don't know". However, in the question it was not specified whether the products cost the same or have the same characteristics. Similarly, Barnes et al. (2011) report that 66.5% of participants prefer a bio-based product over a non-bio-based product. Specifically, participants seemed to prefer products from crops that are not associated with food production. Moreover, locally produced materials and local manufacturing are valued. However, in contrast to these high levels of expressed preference, Blesin and Klein (2017) report that only 12% of participants have ever consciously chosen a bio-based product over a non-bio-based product in actual consumption activities.

Other studies analysed factors generally influencing the consumption decision of consumers. Koenig-Lewis et al. (2014) found that participants' level of concern for the environment

positively influenced their intention to purchase bio-based products. Emotional concern was hereby more influential than a rational evaluation of benefits. Additionally, Scherer et al. (2017) describe that ecologically sensitive participants have a more positive attitude towards bio-based products, but also higher requirements for cultivation and origin of raw materials. Meeusen et al. (2015) describe that consumers are relatively unaffected by the fact that a product is bio-based. It counts as an additional benefit, but personal benefits, such as convenience, price and status are far more important. Reinders et al. (2017) found that the share of bio-based ingredients in a product influence the attitude towards a brand and therefore the consumption decision. Brands with 100% bio-based products resulted in stronger purchase intentions than partially bio-based products.

Table 3 shows aspects that influence the consumption decision of participants positively or negatively. They are clustered in overarching topics, whereby for most topics both positive and negative influences are mentioned. In some cases, the positive and negative aspects are the direct opposite of one another, such as “(not) better for the environment”, “higher/lower price”, “higher/lower bio-based content” and “produced regionally/globally”. Several of the named influences are similar to the connotations shown in **Table 2**, which is not surprising. Aspects that people find positive about bio-based products can result in a positive attitude and may subsequently result in a positive consumption decision. It does stand out, however, that participants mentioned various personal benefits influencing their decision to buy a product.

Table 3: Aspects that influence the consumption decision positively or negatively. Based on: Kurka and Menrad 2009; Rumm et al. 2013; Veldkamp 2013; Carus et al. 2014; Meeusen et al. 2015; Blesin and Klein 2017; Karachaliou et al. 2017; Lynch et al. 2017; Scherer et al. 2017

Positive influence on consumption decision	Negative influence on consumption decision
<p>Product characteristics</p> <ul style="list-style-type: none"> • Just as good as conventional • Improved properties • High bio-based content • Better aesthetics 	<p>Product characteristics</p> <ul style="list-style-type: none"> • Low quality • Low bio-based content
<p>Environment</p> <ul style="list-style-type: none"> • Better for the environment • Certified products • Environmentally friendly cultivation, preferably organic • Substantial CO₂ reduction 	<p>Environment</p> <ul style="list-style-type: none"> • Not better for the environment over the life cycle
<p>Personal benefits</p> <ul style="list-style-type: none"> • Lower prices • Health benefits • Safe to use • No toxic ingredients • Good conscious • Feeling of doing something good • Being more eco-friendly 	<p>Personal benefits</p> <ul style="list-style-type: none"> • Higher prices • Limited availability

<ul style="list-style-type: none"> • Green lifestyle • Convenient 	
Raw materials <ul style="list-style-type: none"> • Produced regionally (e.g. in the EU) • Produced from non-food resources 	Raw materials <ul style="list-style-type: none"> • Produced globally (e.g. outside of the EU) • Resources from GMOs
Disposal <ul style="list-style-type: none"> • Compostable • Recyclable • Reduction of waste 	Disposal <ul style="list-style-type: none"> • Slow biodegradation in nature
Future and conservation of resources <ul style="list-style-type: none"> • Reduced use of oil • Conserve resources for future generations • Contribute to a better future 	Information <ul style="list-style-type: none"> • Lack of relevant information or knowledge about benefits • Lack of labelling or guarantees • Unclear environmental benefits • Unclear how to dispose of products

Willingness to pay (WTP) describes the price a buyer is willing to pay for a certain product. It is a measure that reflects the subjective value that consumers assign to a product. This value includes any “additional value” that a property creates in comparison to a conventional product. In this study, we refer to the willingness to pay more for a bio-based product in comparison to the price of a conventional counterpart. Various studies report on the WTP for bio-based products, but it should be taken into account that the methods used to assess the WTP differ substantially. Most studies establish a theoretical WTP (Kurka and Menrad 2009; Barnes et al. 2011; Hall et al. 2012; Kurka 2012; Meeusen et al. 2015; Lynch et al. 2017), Kainz (2016) determined a WTP in an experimental setting with a virtual market situation and Carus et al. (2014) assessed experts’ experiences.

Two studies generally concluded that participants were willing to pay a little more for bio-based products (Barnes et al. 2011; Hall et al. 2012). Others specified the percentage of participants that was willing to pay more, which lay between 55% and 64% of participants (Kurka and Menrad 2009; Kurka 2012; Kainz 2016; Scherer et al. 2017). Carus et al. (2014) report that consumers are willing to pay between 0-25% higher prices for bio-based products, depending on the product group. They furthermore describe that so-called “Green premiums” are paid along the value chain, often already at an intermediate stage, and are not always passed on to the end consumers. Kainz (2016) report that WTP was found especially when participants were presented with general information about the resource base or a label stating that the product was based on a renewable resource. Additional information about climate and environmental effects did, however, not influence the WTP further. Two studies related WTP to participants interests: Kurka and Menrad (2009) found that participants who rated environmental protection, welfare of future generations and health as important issues were willing to pay more than participants who rated these issues as less important. Lynch et al. (2017) also report that WTP is related to the personal interests of participants and that they were generally willing to pay a little more provided the product is proven to be eco-friendly.

Table 3 shows that lack of information, for example about the environmental impact or benefits of a product, can have a negative influence on the consumption decision. This is closely related to the next theme, addressing the information needs of consumers.

4.4 Information and Labels

The last common theme covered in various studies is the want for information about bio-based products by consumers. Blesin and Klein (2017) state that most participants were interested in information about bio-based products, while Karachaliou et al. (2017) report a general lack of information about bio-based products. Most participants thought that information on the benefits of bio-based products are not readily available. Participants even mentioned the lack of information as a barrier for not consuming more bio-based products. Lynch et al. (2017) report that most participants require reliable evidence about the eco-friendliness over the whole life-cycle of the bio-based products. Topics that were found to be of specific interest or relatively unimportant to participants are shown in **Table 4**.

Table 4: Information requirements: topics of specific interest or relative unimportance. Based on: Meeusen et al. 2015; Kainz 2016; Blesin and Klein 2017; Karachaliou et al. 2017; Lynch et al. 2017; Scherer et al. 2017

Topics of specific information interest	Topics appearing relatively unimportant
Product information <ul style="list-style-type: none"> • Properties • Health impact • Production • Environmental effects 	Product information <ul style="list-style-type: none"> • Functionalities • Social impact
Info on disposal <ul style="list-style-type: none"> • Recyclability • Biodegradability • Compostability 	
Info on resources <ul style="list-style-type: none"> • Bio-based share • Raw materials used • Whether the resources are organic 	Info on resources <ul style="list-style-type: none"> • Agricultural land area needed for resource production • Use of GMOs during resource production

Additional to information wants or requirements, some studies mentioned the use of labels to fulfil these needs. Three studies addressed the effect that labels had. Meeusen (2015) describe that bio-based products with a label were preferred over conventional products and bio-based products without a label. They recommend to producers of bio-based products to differentiate their products on the market through a label. Additionally, Kainz (2016) found that informing participants via a label had a greater effect on WTP than textual information. They argue that the information is conveyed in an easily understandable way and that a label (even an unknown one) establishes trust and credibility. Karachaliou (2017) report that

65.7% of participants agreed that clear certification and labelling of bio-based products would facilitate the growth of the bio-based market.

Rumm et al. (2013) developed labels themselves and tested them on consumers. They found that participants preferred the term "renewable resources" over "bio-based". Furthermore, participants preferred information directly on a label over the possibility to search for further information on the internet. They argue that the term "sustainability" should be avoided, because it appeared to be too complex and abstract. They recommend that a label should give information about the attributes that are of personal benefit for the consumer, about altruistic motives like environmental protection or resource conservation, and about the origin of the raw materials.

Finally, Lynch et al. (2017) report that to rule out greenwashing, participants expressed the wish to receive information from a neutral source. Some indicated a label, others disagreed, arguing that already many labels exist, which would make information more confusing.

These results show that consumers are interested in details about bio-based products that in turn influence their buying decision. The information is given in texts or explanations in the studies, but this is not necessarily realistic for real market situations. Labels might help to solve this, especially since most participants preferred labels, but are not undisputed.

4.5 Barriers

4.5.1 Awareness and Knowledge

The results show that the awareness of the existence of bio-based products seems to lie around 50%. While there is a general understanding of what bio-based products are among this consumer group, specific knowledge about product characteristics is mostly missing and misconceptions occur. The relatively low level of awareness can be a barrier for further market development of bio-based products, if the fact that they are bio-based is to be the unique selling point. In some cases, producers might want to market their products as bio-based, in others, they may choose to simply advertise a lower price or better properties. Awareness is especially important in the first case. This is similar for knowledge: if consumers are to be convinced to buy bio-based products, a low level of knowledge about advantages of bio-based products can be counterproductive. However, it is questionable whether this can be solved on a general level – bio-based products have very different properties and impacts, and general knowledge may not be helpful or convincing to consumers, if they do not receive specific information about the bio-based product in question.

4.5.2 Associations and Connotations

As described above, consumers link various associations and connotations with bio-based products. Associations are related to environmental aspects, personal benefits and product properties. Various studies show that people assume that bio-based production is aimed at finding environmentally friendlier solutions. This results in a positive attitude towards bio-based products, but also brings with it the problem of high expectations towards them. Furthermore, some common misconceptions are prevailing, such as the assumed link between bio-based and organic products or the assumptions that bio-based products are biodegradable or recyclable. These high expectations and misconceptions bring with it the danger of disappointment, and consequentially a negative consumption decision, if bio-based products do not possess the expected characteristics.

There appear to be as many positive as negative connotations about bio-based products. The negative connotations in themselves could prove barriers for further market development. It stands out that on both the positive and the negative side, many are related to the impact on the environment and refer to a global scale. The factual environmental impact of a bio-based product could thus prove to be a very important aspect in the final attitude of consumers. A difference in scale was noticed for economic connotations: positive connotations are related to rather global advantages, while negative ones are on a personal scale. As Meeusen et al. (2015), Lynch et al. (2017) and Rumm et al. (2013) pointed out that personal benefits are most influential on perception and consumption decision, these negative connotations could be especially disadvantageous. While expected health benefits and innovativeness of bio-based products are valued positively, participants do not seem to trust bio-based producers completely regarding their claims and are concerned about ethical issues.

4.5.3 Consumption Decision and Willingness to Pay

The results show that around two thirds of participants state to prefer bio-based products over conventional products (given no other restraints, like a difference in price), but only 12% have ever consciously chosen bio-based products over conventional ones. On the one hand, this could be related to limited availability. On the other hand, it shows that the consumer pool that actively chooses bio-based products is small, but has potential to grow. Analysing the motives of consumers more closely shows that consumers generally drawn to environmentally friendly products also have a more positive attitude towards bio-based products and are willing to pay more for them. Most consumers, however, are relatively unaffected by the fact that a product is bio-based. It counts as an additional benefit, but personal benefits are far more important in the consumption decision. This shows that the fact that a product is bio-based is only of real importance to a niche market.

Environmentally conscious consumers have a more positive attitude but also higher requirements for cultivation and origin of raw materials. And their willingness to pay more is

conditional to the bio-based product proven to be eco-friendly. The share of bio-based content in a product influences the attitude of consumers. The influence can be both a positive and a negative influence, depending on their expectations of what a fair bio-based share would be. In quite a few cases, the positive and negative aspects are the direct opposite of one another. It depends on what specific aspects a consumer prioritises whether the aspects lead to a positive or negative consumption decision.

Finally, it stands out that participants mentioned a range of personal benefits influencing their decision to buy a product, considering that personal benefits were not mentioned when consumers were asked to mention connotations. It illustrates the importance to focus communication on personal benefits (potentially communicated through a label, as mentioned by Rumm et al. (2013).

Willingness to Pay is a relevant issue for public acceptance only in those cases where bio-based products will be more expensive and the higher price is not compensated by better product functionalities. Moreover, the fact that a product is bio-based is only one aspect among many others that influence buying decisions. The results –mainly of theoretical studies– show that a significant percentage of participants (between 55% and 64%) would be willing to pay a little bit more for a bio-based product than for a conventional product, mainly if the benefits of the resource base are clear to them. The results also found WTP to be related to the personal interests of consumers in e.g. health and the concern of consumers about the environment, welfare and future generations. This suggest that a higher WTP would be found mainly in a niche market.

4.5.4 Information and Labels

Most participants thought that information on the benefits of bio-based products is not readily available. Participants even mentioned the lack of information on these benefits as a barrier for not consuming more bio-based products. This need for differentiated information, however, is contradictory to the need for simplicity stated in other contexts.

Labels were mentioned as being more effective to present detailed information than textual information. A multitude of ecolabels exists in Europe. The strongest type of ecolabel is the one that is voluntary, multiple-criteria based, and third party operated (i.e. ISO 14024 type I) (Eder and Dammer 2015). Few of the ecolabels are specific enough for most bio-based products. There are three Type I ecolabels that cover specific product categories that include bio-based products: the EU Ecolabel (symbolised by the flower), the Nordic Ecolabel (from the Nordic countries) and the Blue Angel ecolabel (from Germany). There is no ecolabel that was developed purposely for bio-based products. Creating such a label would be a costly exercise, after which it may take a very long time before a label is known to consumers, if ever. It seems doubtful that those labels focussing specifically on the fact that a product is bio-based (these do exist, without a focus on environmental aspects) would be convincing for a general public, since many participants were not convinced purely by the fact that a

product was bio-based. It is seen merely as an added value next to other product properties and impacts. Consequently, these purely 'bio-based' labels are mostly used in the B2B context as of today.

When presented mock-ups of self-developed labels, participants preferred information directly on a product label over the possibility to search for further details on the internet⁵ (Rumm et al. 2013). The label should give information about altruistic motives like environmental protection or resource conservation, and about the origin of the raw materials. The term "renewable resources" is preferred above "bio-based" and the term "sustainability" should be avoided.

Finally, attributes that are of personal benefit for the consumer should be advertised.

4.5.5 Perception of Biotechnology

Opinion Leader (2009) presents findings of qualitative and exploratory research on public perceptions of Industrial Biotechnology (IB). They conclude that the main barrier to public acceptance of IB is fear of the unknown, based on a limited knowledge of science in general and a fundamental lack of understanding of IB specifically. This vacuum of information is currently being filled with stories about the more controversial developments, namely GM and biofuels, thus creating immediate emotive associations which will need to be overcome.

There are some very complicated messages to communicate around IB in order to gain public understanding and potentially acceptance. Furthermore, there are elements of IB that the public find worrying, even with greater understanding, e.g. GM crops, cost, quality and land use in developing countries.

Negative messages in the public domain about these issues could have a dramatic impact on public acceptance. People are keen to hear what NGOs, such as Greenpeace and Friends of the Earth, think about these emergent technologies. Indeed, the views of these organisations, and others independent of government and industry, such as think tanks, are largely perceived as credible sources. An opposing view from these organisations is likely to be given weight by the public.

In the bio-based product surveys it stands out that the use of GMOs in raw material production are named as a negative influence on the consumption decision, but participants still found it relatively unimportant information if GMOs are used.

⁵ This could for example be done through a barcode-scanner app similar to CodeCheck (www.codecheck.info), a platform that provides independent information about food and cosmetics ingredients to the customer in a user-friendly way.

5. Discussion

5.1 Comparability of results of evaluated studies

We systematically identified common themes and filtered out relevant results from different studies. Due to very divergent methodologies of the studies, comparability of results is limited. Differences in the objects of the studies, the different bio-based products referred to, that may influence people's specific interests and opinions were ignored. However, this was the best way to create a general overview and through the representation of results in a qualitative, descriptive way, we avoided misconceptions that would have arisen from comparison of numbers where results are not comparable. The Report often comprises the breadth of results and all results found regarding a theme, and not distinguishing in how many studies it was mentioned (unless stated). This is in line with the objective of Del 2.2 to highlight trends and general developments.

5.2 Sample representativeness of evaluated studies

Most studies and surveys aimed for a representative sample, in terms of age, gender, education and income distribution. However, at least 5 studies appeared to be non-representative. In particular (but not only) in multi-country studies, the geographical representativeness of the sample can be an issue. Self-selection can also be a bias. In many studies education level and household income were often (somewhat) higher than the national average, sometimes due to the research method applied (e.g. online survey). Generally speaking the larger surveys, with at least 500 respondents, where the most representative (i.e. Meeusen et al. (2015) and Blesin and Klein (2017)).

5.3 Identification of gaps evaluated in studies

Some of the basic assumptions of the evaluated studies may not be entirely correct. Based on Dammer et al. (2017) the following observations can be made.

Almost all consumer research on bio-based products focuses on issues such as environmental sustainability, and completely ignores that consumers could favour bio-based products if they provide improved functionalities without any added environmental benefits. If marketing and consumer communication focus too much on environmental topics alone, it can bear the danger that bio-based products which do not demonstrate clear environmental benefits (but may provide excellent properties or show other advantages) are vulnerable to skepticism by consumers fueled by unrealistic expectations.

While it might be the reality in many cases that bio-based products are more expensive than their conventional counterparts, it would be misleading to conclude that a lack of willingness to pay these higher prices is somehow related to a lack of acceptance of bio-based products.

Rather, the only valid conclusion from this fact would be that the resource base is not a decisive factor for a buying decision (“consumers do not care” instead of “consumers are skeptical of bio-based products”) and that therefore price is a much stronger motivator for consumers. It would be indeed interesting to assess whether the average consumer is aware of the resource base of a conventional product in order to provide a valid basis for comparing acceptance.

While many studies in this field conclude that transparent information is key to motivating consumers to buy bio-based products, the surface has barely been scratched when it comes to assessing which information is necessary and in which form it should be presented. Nowadays, consumers are confronted with an extreme multitude of products from which they need to choose in combination with an excess of information available to everyone who wants to look for it. In the context of discussions about attention economy, it seems to be a crucial question on how to package and present information on bio-based products in order to catch consumers’ attention and convince them of the benefits of such products. We presented the current knowledge on this issue in this report, but there is room for further work in this area.

6. Overarching insights

The above survey findings regarding the four themes, the various identified barriers and possible approaches how to help overcome these barriers were presented to and discussed with the RoadToBio experts at a project meeting in November 2017. The meeting helped to fine-tune and expand the approaches. The results of this internal discussion are presented below. The presented ideas will be built upon and elaborated in the coming months.

6.1 Awareness and Knowledge

It would appear that consumers do care about products being environmentally-friendly, but do not particularly care whether a product is bio-based or not. This would imply that (a) on the large, being bio-based is not a unique selling point (it is merely a differentiator); (b) it is not necessary that the consumer understands what a product being bio-based means; (c) communication should not focus on the fact that a product is bio-based only, but especially highlight the direct advantages for the consumers and positive impacts of the renewable resource base (e.g. regarding improved properties or functionalities, environmental impact, social impact or ethical considerations) .

So when communicating about bio-based products, it seems best to go for one of two options. Option A: informing the consumer that the product is bio-based, and providing information what impacts this has (in comparison to conventional processes). Option B:

inform the consumer that the product is better and nice to have, using other arguments while not mentioning bio-based at all.

6.2 Associations & Connotations

It would appear difficult to overcome the multiple negative connotations (related to environment, economics, trust and ethics) with a single instrument. Instead, a diversified approach focussing on multiple aspects would be needed.

General misconceptions and valid concerns can be removed or addressed, on the one hand through education and, on the other hand, through promotional and public relations activities of the industry. The positive connotations described above could provide inspiration, for example consumers' preference for regional or local production and waste reduction etc.

Environmental connotations may be addressed through informing the consumer about the results of a life cycle assessment (LCA). This has to be carried out at the product level, making this an expensive instrument.

Valid concerns about product quality require an improvement of the product quality.

Lack of trust may be tackled through product branding.

6.3 Consumption decision and WTP

If a brand owner or retailer is not prepared to focus on a niche market, he should focus on the personal benefits that bio-based products bring (potentially communicated through a label) and be aware that most consumers are only willing to pay little or no more for bio-based products.

In some cases it may be determined or perceived that the consumer is unwilling to pay the green premium for a bio-based product of equal quality. In other words: no higher price can be charged for the bio-based product. In this case brand owners of consumer products may take the initiative that actors along the value chain carry the burden and absorb the higher product costs. This strategy has been applied in the recent past by brands such as Coca-Cola and IKEA. It allows brands to focus on image and branding, looking at the problem from a different perspective.

6.4 Information and labels

A product being bio-based is just part of the story. Telling the story works better with a label than with a text. A label presenting information about the product must not be a label for bio-based, but tell the entire story. The label should give information about the attributes that are of personal benefit for the consumer, about altruistic motives like environmental protection or resource conservation, and about the origin of the raw materials.

It is contradictory, and therefore a challenge, that consumers indicate they want to be informed, but when it comes to putting effort in to informing themselves this switches to easily available information, such as a (“simple”) label.

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Annex I: Details on evaluated publications

Authors	Year	Title	Source	Institution	Study goal	Study region	Study period	Products	Sample size	Sample representativeness
Barnes M, Chan-Halbrecht C, Zhang Q, Abejon N	2011	Consumer preference and willingness to pay for non-plastic food containers in Honolulu, USA	Journal of Environmental Protection, 2011 vol: 02 (09) pp: 1264-1273	University of Hawaii at Manoa, Honolulu, USA	1) determine the public's preferences for takeout food containers made with alternative plant-based materials; 2) explore different plant-based food container market segments using latent class analysis; 3) calculate willingness to pay (WTP) for plant-based alternative food containers and the preferred food container attributes	urban centre of Honolulu, Hawaii, USA (all suburbs and districts)	Spring 2011	Plant-based EPS (expanded polystyrene) alternative takeout food containers	Conjoint Choice Experiment (CCE); n = 244	Fairly representative of Honolulu's population.
Blesin J-M, Klein F	2017	Status Quo: Bevölkerungs- und Verbraucherwahrnehmung von Biokunststoffen. Vortrag bei "Herausforderungen und Chancen der Bevölkerungs- und Verbraucher-kommunikation über Biokunststoffe" im Rahmen des BMBF Forschungsprojektest BiNa	Workshop held on 16 Feb 2017, Hanover (Germany)	HS Hannover & HS Weihenstephan-Triesdorf	Assess (a) perceptions of bioplastics among the German public and economic, political and society actors and (b) consumers perception and product-experience regarding bioplastic products, means of communication, strategies	Germany	July 2016	Bioplastics	n = 1673	Sample age distribution was close to national age distribution
Karachaliou E, Tsagaraki E, Deligiannidis I, Kouzi E	2017	Public perception of bio-based products	H2020 project deliverable	Q-PLAN (Greece)	Understanding the characteristics and potential of bio-based products and applications as well as an analysis of the level of public awareness and acceptance of bio-based products.	Europe (mainly partner countries EE, IT, GR, PT, SK, ES)	5 April - 10 May 2017	Bio-based products (BBP)	n = 452	Majority of answers were collected in countries where the questionnaire was disseminated in national language. The majority of participants were 25-40 and 40-65 years old.
Carus M, Eder A, Beckmann J	2014	GreenPremium prices along the value chain of bio-based products		nova-Institut GmbH	Assess the extra-price market actors are willing to pay for a product just for the fact that it is bio-based			35 bio-based chemicals, polymers, plastics (drop-in & new biopolymers), and compounds		
Hall C, Behe B, Campbell B, Dennis J, Lopez R, Yue C	2012	The appeal of biodegradable packaging to US floral consumers	Acta Horticulturae, 2012 vol: 930 pp: 121-126	Texas A&M University, Michigan State University, Purdue University, University of Minnesota	To compare consumer preferences for biodegradable versus traditional containers. To determine the characteristics of biodegradable pots that consumers deem most desirable and to solicit their willingness-to-pay (WTP) for this type of product.	Indiana, Michigan, Minnesota & Texas (USA)	July 2009	Biodegradable pots / plant containers (incl. those made from peat, coconut coir, poultry feathers, cow manure & recycled plastic)	Conjoint analysis internet survey (535 qualifying respondents)	Representative of the US population (were chosen by a random selection of telephone numbers or addresses)
Kainz U	2016	Consumers' Willingness to Pay for Durable Biobased Plastics Products: Findings from an Experimental Auction	Doctoral Dissertation	TU Munich (Germany)	Measure general attitudes towards biopolymers and renewable resources as well as attitudes towards environmentally friendly and regionally produced products	Germany	May-June 2013 (online survey); February 2014 (experiments)	Biopolymer consumer products. For bidding experiments: sunglasses and toothbrush	Online survey: 70 questionnaires were filled out completely; Experiments: n = 227 (six treatments with 40 randomly assigned participants (two sessions with 20 participants each))	The online survey did not require representativeness. Compared to the Bavarian average, the sample was slightly younger, overrepresented men and was better educated. Household net income was slightly higher than the German average
Koenig-Lewis N, Palmer A, Dermody J, Urbye A	2014	Consumers' evaluations of ecological packaging – Rational and emotional approaches	Journal of Environmental Psychology, Volume 37, March 2014, Pages 94-105	Norway	Investigates consumers' emotional and rational evaluations of pro-environmental packaging	Norway	January 2011	Beverage container incorporating organic material	online survey: n = 312 (fully completed questionnaires)	Sample gender split was close to the gender split nationally. Sample mean age was 26.3 years. Sample occupation split in line with occupation split nationally.
Kurka S	2012	Biomasse-basierte Produkte aus Konsumentensicht - ausgewählte Europäische Länder im Vergleich	Doctoral Dissertation	TU Munich (Germany)	Examine consumer behaviour towards bio-based consumer products in three EU-countries. A particular focus was the measurement of willingness to pay (WTP).	Germany, Netherlands, Sweden	May-August 2008	Washing up liquid, shampoo, fruit juice in a bioplastic bottle, and a mobile phone	n = 510-515	Sample only partially representative of the population in sample countries. Gender distribution is almost identical. Census data on age, marital status, number of persons in households and incomes were comparable. Education level in sample, however, is significantly higher in comparison to the census data.

Kurka S, Menrad K	2009	Report of market acceptance of biorefinery concepts amongst consumers	FP6 project deliverable	TU Munich (Germany)	Survey market acceptance of biorefinery concepts and biobased products amongst consumers; analyse customers' willingness to pay for selected biobased products.	Germany, UK, Sweden, Poland, Greece and Netherlands	Mid-2008		n = 639-667	The sample doesn't represent the population of the six surveyed countries in an adequate way. Greece, Poland and UK were underrepresented, and face overrepresentations of different issues. For the other three countries on the whole a uniform distribution can be reached, except for the education level (insufficient representation of
Lynch DHJ, Klaassen P, Broerse JEW	2017	Unraveling Dutch citizens' perceptions on the bio-based economy: The case of bioplastics, bio-jetfuels and small-scale biorefineries	Industrial Crops and Products, Volume 106, 2017, Pages 130-137, ISSN 0926-6690	Altena Institute, VU Amsterdam	Explores citizens' perceptions of the BBE, focusing on their arguments in favour of and against BBE, as well as their opinion of considerations for successful implementation of bio-based innovations	Amsterdam (FG on bioplastics / bio-jetfuels); Doetinchem (FG on small-scale biorefineries)	February-September 2014	Bioplastics, bio-jetfuels and small-scale biorefineries	n = 57 (seven focus groups discussions)	To avoid self-selection bias of the participants, a recruitment agency was tasked to select participants based on our selection criteria.
Meeusen M, Peuckert J, Quitzow R	2015	Acceptance factors for bio-based products and related information systems	FP7 project deliverable	Wageningen UR	The identification of key criteria for the market acceptance of bio-based products and related standards and information systems, including labelling options for bio-based products.	Six EU countries: Germany, Netherlands, Italy, Slovenia, Denmark, and Czech Republic	Focus groups: May-June 2014; Online survey: December 2014	(FGs:) t-shirt, foot cream, shopping bag, Coca-Cola bottle, door trimming dashboard, WPC decking and natural paint	(Focus groups:): n = 89 in five countries; (Online survey): n = 6,228 in six countries	Sub-contracted market researcher GfK was instructed that samples should be representative of the specific country in terms of age, gender, education, and income distributions.
Reinders MJ, Onwezen MC, Meeusen MJG	2017	Can bio-based attributes upgrade a brand? How partial and full use of bio-based materials affects the purchase intention of brands	Journal of Cleaner Production, Volume 162, 2017, Pages 1169-1179, ISSN 0959-6526	Wageningen UR	Examine how consumers may evaluate brands that use different percentages of bio-based materials. Gain a deeper understanding of how the use of bio-based materials affects consumers' purchase intentions. Explore under what conditions the strength of the examined relationships may alter.	Six EU countries: Germany, Netherlands, Italy, Slovenia, Denmark, and Czech Republic	December 2014	Study 1: Garnier shampoo. Study 2: the packaging of soft drinks (i.e. Coca-Cola and other colas)	Two online experimental studies. Study 1: n = 1873. Study 2 = 3741	Sub-contracted market researcher GfK was instructed that samples should be representative of the specific country in terms of age, gender, education, and income distributions.
Opinion Leader	2009	Public perceptions of industrial biotechnology			Explore public perceptions of industrial biotechnology		October-November 2008			
Osburg V-S, Strack M, Toporowski W	2013	Products consisting of innovative Wood Polymer Composites: Is there a market for ecologically aware consumers?	First Intern. Conf. on Resource Efficiency in Interorganizational Networks ResEff 2013. 2013 pp: 415-426	University of Hull, Georg-August-Universität Göttingen	Explores whether common findings regarding traditional eco-friendly materials also hold up for WPC	Germany	? (2012 or 2013)	Three materials (solid wood, Wood Polymer Composites - WPC, plastic)	Online survey (n = 198)	The sample was not representative. Participants were younger adults aged 18-40 years, 38 per cent of participants was male, 69 per cent were university students.
Rumm S, Klein A, Zapiiko M, Menrad K	2013	Labelling for bio-based plastics	First Intern. Conf. on Resource Efficiency in Interorganizational Networks ResEff 2013. 2013 pp: 403-414	Straubing Centre of Science, Weihenstephan-Triesdorf University of Applied Sciences	Pilot study to detect what visual details and information with regard to content are important for consumers when assessing a label for plastics made from renewable resources.	Straubing (Bavaria, Germany)	? (2012 or 2013)	Plastics made from renewable resources.	n = 70 (fully completed questionnaires)	This pilot study is non-representative and exploratory. Educational level of the sample is higher than the national average. Females as well as employees and officials are over-represented. Almost half of the participants live in cities between 20,000 and 99,999 inhabitants.
Scherer C, Emberger-Klein A, Menrad K	2017	Biogenic product alternatives for children: Consumer preferences for a set of sand toys made of bio-based plastic	Sustainable Production and Consumption, Volume 10, 2017, Pages 1-14, ISSN 2352-5509	Straubing Centre of Science, Weihenstephan-Triesdorf University of Applied Sciences	Identify important product attributes and the preferred characteristics of a set of bio-based sand toys for children.	Germany (online panel, 521 pers.)	November 2014	Sand toys made of bio-based plastic	n = 521 (choice-based conjoint analysis)	Survey respondents live in smaller households and have a slightly higher income in comparison to the relevant part of the German population. Furthermore, they have higher education qualifications

Veldkamp	2013	Publiekonderzoek biobased economy: kennis, houding en gedrag	n/a	Veldkamp, Amsterdam	This research gives insight what citizens know of the biobased economy, what their attitude is and how far they are willing to work towards transition to a biobased economy. It provides connection points for communication on the bio-based economy.	Netherlands	17 -23 September 2013	Energy production, transport fuels, packaging materials	n = 1553	
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