Open-BIO

Opening bio-based markets via standards, labelling and procurement

Work Package 9: Social Acceptance

Deliverable N° 9.2 / Annex I

Acceptance factors for bio-based products and related information systems among consumers

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Deliverable 9.2 / A I: Acceptance of Bio-Based Products among Consumers

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1. Introduction and objective

The present deliverable was carried out within the project KBBE.2013.3.3-03 'Opening bio-based markets via standards, labelling and procurement'. The objective of this project is to increase the uptake speed of standards, labels and harmonized product information lists for bio-based products.

The present deliverable builds on Deliverable 9.1 (Annex I), Acceptance of Bio-Based Products by consumers – an exploratory study. Deliverable 9.1 provides an overview of current knowledge regarding consumer acceptance of bio-based products. This report explained that there is not much known about consumer perceptions and acceptance of bio-based products. Deliverable 9.1. furthermore describes a number of streams of research that can be used to understand consumer perceptions of bio-based. Additionally, a qualitative research was conducted in six countries that provides a first insight in people's experiences, opinions, wishes, and concerns regarding bio-based products.

The present deliverable aims to deepen these insights of Deliverable 9.1 by a quantitative study on consumer perceptions of, and attitudes towards, bio-based products. A questionnaire was formulated that was sent to a representative sample of consumers in six Member States (i.e., Denmark, Germany, Italy, The Netherlands, Czech Republic, and Slovenia). This survey enables the researchers to identifying the most relevant issues in consumer acceptance of bio-based products, in order to gain insight into the market potential of these products on the European market.

This report is structured as follows. First, in the next chapter, a conceptual background is presented in which the different research questions are formulated that will be addressed in the consumer survey. Subsequently, in Chapter 3, the method of the consumer study will be explained, followed by a description of the results of the survey in Chapter 4. The report closes with a discussion of the main results accompanied by some practical implications.

2. Methodology

This chapter describes the methodology. It starts with the conceptual background of the quantitative consumer research and the main research questions. Then we describe the sample, followed by an explanation of the questionnaire and the experimental design used in the questionnaire.

2.1. Conceptual background

We distinguish five different parts:
- General perceptions of bio-based products;
- Factors explaining consumer acceptance of bio-based products;
- Role of branding and percentage of bio-based materials;
- Communication and labelling;
- Personal characteristics.

We subsequently describe each of these parts and the research questions pertaining to each part in more detail below.

2.1.1. General perceptions of bio-based products

The first part quantifies consumers' perceptions and associations with the term bio-based. The results of the focus groups among consumers (Deliverable 9.1, Annex I) were used as a starting point. The focus groups revealed that associations with bio-based were often linked to environment-related terms. Other keywords were used less often, for example, technical-, health-related and human rights-related aspects. Still, the results indicate that participants have a wide range of associations with bio-based. Furthermore, there is variation in participants' familiarity with bio-based. For example, those unfamiliar with bio-based tend to categorize bio-based under keywords that include 'bio' such as bio fuel, biodegradable, biotechnology, whereas those participants that were more familiar with bio-based grouped bio-based with keywords like organic, environmental friendly, no animal testing, and to a lesser extent natural, sustainable, independent from oil, and recyclable.

In the survey we want to quantify these findings, by both asking open association questions as well as receiving consumers' ratings of bio-based products according to a number of product attributes. In sum, by doing so, we aim to answer the following research question: *What associations do consumers have related to bio-based products and what is consumer's familiarity with bio-based products?*

2.1.2. Factors explaining consumer acceptance of bio-based products

In this part we aim to explore which factors determine consumer acceptance and intention to buy bio-based products. The underlying model that we will use for this part is the Theory of Planned Behaviour. In social science, the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) and it's follow-up model the Theory of Planned Behaviour (TPB; Ajzen, 1991) are widely applied to explain acceptance of novel products (e.g., Crespo & Del Bosque, 2008; Jaruwachirathanakul & Fink, 2005). The TPB states that Perceived Behavioural Control (i.e. the perception whether one is able to actually perform the behaviour), social norms (i.e. perception of whether significant others are likely to accept a novel technology) and attitude (i.e. positive or negative evaluation of engaging in the specific behaviour), are determinants of intention, which in turn affects behaviour (Ajzen, 1991).   Attempts have been made to combine and integrate the TPB with different theories of consumer acceptance of innovations to enhance predictive ability. An integration of existing models can lead to a better understanding of consumer behaviour in the context of adoption of innovations (Lee et al., 2003). More specific, a body of research states that the attitudinal models (e.g., TPB) can be further improved by differentiating attitudes in risk and benefit perceptions (e.g., Lee, 2009; Ronteltap et al., 2007). Perceived costs and perceived benefits are major determinants of consumers' acceptance of new food technologies (Ronteltap et al., 2007). More, specific, these theories state that individuals decide whether to accept a technology when benefits outweigh the risks.

Ambivalence

The current study states that the rational risk-benefit approach can be improved by including ambivalence. Many people remain "ambivalent", holding neither positive or negative information, after receiving balanced information (Fischer et al., 2013). Ambivalence refers to the extent to which an individual evaluates an object to consist of both negative and positive elements simultaneously (Jonas, Broemer & Diehl, 2000) and is generally experienced as an aversive state (van Harreveld, Rutjens, Schneider, Nohlen, & Keskinis, 2014). Note that ambivalence is not the same as a lack of understanding. Individuals are unable to form attitudes regarding perceived risks and benefits associated with a technology when they have a low understanding (Frewer et al., 1994).

Positive and negative emotions

Additionally, we aim to explore how ambivalence affects intentions. On the one hand it is possible that ambivalence affects consumer acceptance via both positive and negative emotional experiences, as consumers might perceive both risks and benefits. On the other hand it is possible that ambivalence affects intentions via negative emotional experiences because it is generally experienced as an aversive state (van Harreveld, Rutjens, Schneider, Nohlen, & Keskinis, 2014).

To explore how ambivalence affects intentions we follow a line of research that includes emotions in the TPB. These researchers state that individuals not only make decisions

based on cognitive evaluation, but that emotional reactions also play an important role in understanding human behavior (Nerb & Spada, 2001; Nyer, 1997; Onwezen et al., 2013a; 2013b). Recent research suggests that the incorporation of affect into TPB can greatly enhance the predictive power of the model (Ajzen, 2011; Rivis, Sheeran, & Armitage, 2009). Additionally, a recent study of Koenig-Lewis and colleagues (2014) shows that a model adding emotions to a typical TPB model including perceived risks and benefits increases the understanding in consumer acceptance of, in this case, a plant-made bottle.

Taken together, the main research question of this part is: To what extent does the developed attitudinal model (including ambivalence and positive and negative emotions) explain consumers' intention to buy bio-based products?

Figure 1: Model for evaluation of bio-based products
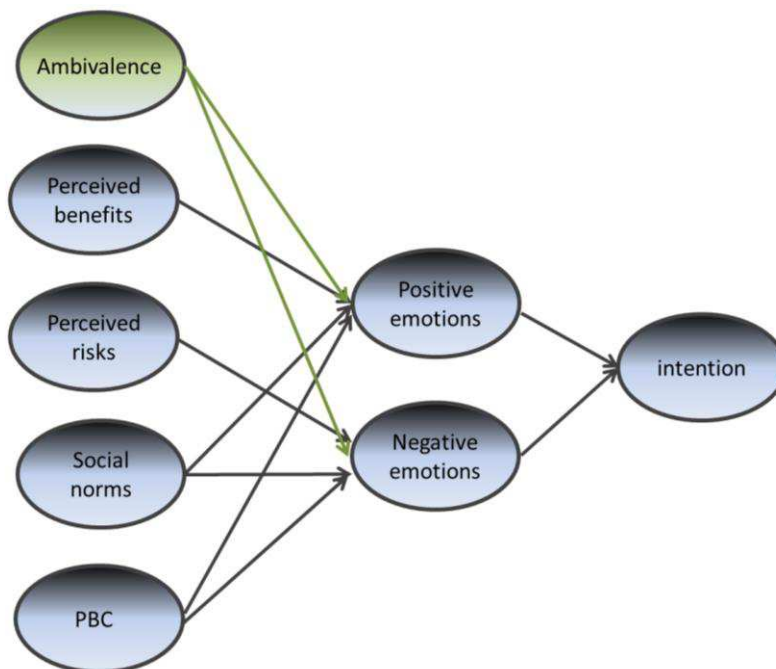
2.1.3. Role of branding and percentage of bio-based materials

This part of the study aims to investigate the role of branding in acceptance of bio-based products. Additionally, we explore the extent to which this process differs for different products and brands. Brands increasingly try to differentiate themselves on the basis of environmental brand attributes. Although most of the times these initiatives are welcomed by consumers, this is not always the case. From a consumer perspective 'green branding' can be understood as company's attempt to contribute their share to face environmental problems or as a way to cut costs or a marketing tool to increase the sales of their products. In the latter case, companies risk to be convicted of 'greenwashing', where consumers are misled regarding the environmental practices of a company. Under such conditions, the potential benefits of communicating the use of bio-

based materials may be detrimental for the evaluation of a company's brand, even for companies who truly try have the best intentions (Parguel et al., 2011). It is therefore interesting to test whether adding bio-based materials to a product could have an effect on consumer's evaluation of the brand.

Next to so-called global brands like Coca-Cola, retailers are increasingly incorporating 'green' issues in their private labels (Aouina Mejri & Bhatli, 2013). We make a distinction between national brands and private label brands, because consumers might have different expectations and perceptions regarding these two different brands. Hence, our first research question for this part of the survey is: *Can the use of bio-based materials upgrade a brand? And does this differ between national brands and private label brands?*

Secondly, the extent to which products make use of bio-based materials could also play a role in consumer's evaluation of the brand. Stated differently, does it matter whether a company's product or brand is only partially using bio-based materials or does it need to go all the way in order to get consumer's approval. Our second research question for this part of the survey is therefore: *Does the percentage of bio-based materials (i.e., 0%, 30% or 100%) matter for the evaluation of the product?*

Using an experimental design, we test the effect of adding bio-based attributes on consumers' evaluation of a brand (i.e., global brands versus private labels) as well as whether different degrees of the use of bio-based materials (i.e., no, partly or total) play a role.

2.1.4. Communication and labelling of biobased products

The fourth part of the consumer study focuses on how bio-based products can best be communicated and labelled to be accepted by consumers.

Green marketing is growing and growing. It is even said that ecologically sustainable products will not be commercially successful if green brand attributes are not effectively communicated (Hartmann et al., 2005). Having the right communication is crucial to create awareness and to minimize consumers' skeptiscism (Du et al., 2010). However, less is known on what proposition or positioning best fits consumer's needs when communicating about bio-based products. This leads therefore to the following research questions: *How should bio-based products be communicated? What aspects are most important in communication and which communication sources are trusted most?*

Certification and labelling represent important vehicles for codifying and diffusing information on technology, and they have been found to play an important role for the market uptake of innovations (OECD, 2011). In the field of environmentally-friendly products in particular, they may play an important role in supporting market acceptance by ensuring, verifying, and visualizing key sustainability aspects. However, while an overwhelming majority of business experts is convinced that the creation of a European label would help to promote the market for bio-based products, scepticism with regard to

the creation of "just another label" is significant among consumers. We therefore examined the following research question: *What is the added value of labelling bio-based products with a logo or label?*

2.1.5. Personal characteristics

Finally, in the consumer study, we look at a number of personal characteristics that could influence the perception and evaluation of bio-based products. Not all consumers are the same, these personal characteristics are added to explore differences across consumers. It is plausible to expect that certain specific groups of consumers react differently on the abovementioned research questions related to bio-based products.

Relevant literature recognises the role of the following personal characteristics. These characteristics are thus expected to strengthen the effects of previously mentioned factors that explain consumer acceptance such as risks, benefits and norms on intentions (Section 2.2). In this way we reveal personal differences in consumer acceptance of bio-based products.

Subjective knowledge.

Consumers rely on their knowledge when learning about new products. A distinction can be made between objective and subjective knowledge: objective knowledge represents what consumers factually know about a product, whereas subjective knowledge is how much consumers think they know about the product (Park et al., 1994). Moorman et al. (2004) found that subjective knowledge influences the choice a consumer makes. In addition, previous research has considered subjective knowledge as a moderator of the relationship between attitudes and purchase intentions (Berger et al., 1994; Fu & Elliott, 2013).

Domain-specific innovativeness.

Domain-specific innovativeness (DSI) refers to a tendency to acquire new products or new product-related information within a specific domain (Goldsmith & Hofacker, 1991). Previous studies in different contexts have shown that domain-specific innovativeness is positively related to consumers' evaluation and adoption of new products (e.g., Bartels & Reinders, 2011; Citrin et al., 2000; Huotilainen et al., 2006; Lu et al., 2008).

Personal orientations.

Individual differences in health orientation (Roininen & Tuorila, 1999) and safety orientation (De Jonge et al., 2007) are found to be rather stable factors in understanding consumer (food) choices. Health orientation aims to measure the general interest in health of consumers (Dutta-Bergman, 2004). Safety orientation aims to measure consumer worries and desires about product safety (De Jonge et al., 2007).

Personal norm (towards the environment).

This construct reflects a moral obligation to perform environmentally friendly behaviour and as such plays an important role in explaining environmentally friendly behaviours (Gärling et al., 2003). According to Hopper and Nielsen (1991), personal norms are derived from socially shared norms that are internalized as moral attitudes. There are individual differences in personal norms and these norms are found to guide consumers towards environmental choices.

2.2. Sample

A cross-national online consumer survey was run in six different countries – Denmark (*N*=1012), Germany (*N*=1136), Italy (*N*=1060), The Netherlands (*N*=1016), Czech republic (*N*=1008), and Slovenia (*N*=1011). The six countries were selected to represent a wide range of European countries. The countries were selected in two steps. In the first step, to achieve a geographical balance over Europe, countries were selected from different European regions: (i) Western Europe, (ii) Eastern/ Central Europe, (iii) Scandinavia and (iv) Southern Europe / Mediterranean. In the second step, member states were screened for their frontrunner status in the field of environmentally-friendly products (purchase of environmentally-friendly products, purchase of energy efficient appliances, awareness of environmental impacts of products, awareness of sustainability labels) and in the field of biotechnology (support for biotechnology and genetically-modified food).

The data were collected in December 2014. The survey was administered by a professional market research company. In all countries, we instructed the market research company that our study samples should be representative of the specific country in terms of age, gender, education, and income distributions. In total 6241 respondents completed the questionnaire. Thirteen respondents were removed because they showed zero standard deviation, indicating that they did not answer the survey seriously (all questions were answered the same). This brings the used sample to 6228 respondents.

The sample consisted of 49.2% males. In general most of the respondents fall within the age group of 50 to 64 years old. All demographic characteristics of the respondents (e.g., income level, children, social status) are divided across answering categories showing broad samples. The demographics are shown in Appendix A.

2.3. Procedure

Respondents completed a self-administered online questionnaire that included (1) questions regarding their associations with, and perceptions of, bio-based products, (2) questions regarding the factors that determine acceptance of bio-based products, (3) an

experimental design that measured the role of branding and percentage of bio-based materials, (4) questions dealing with communication and labelling of bio-based products, and (5) questions focussing on the personal and socio-demographic characteristics of the respondents.

All items were randomised for each of the measures. The items and the Cronbach's alpha's of the multi-item constructs are shown in Appendix B. Unless otherwise indicated, seven-point Likert scales will be used, with end-points: 1= 'totally disagree' to 7= 'totally agree'. The questionnaire was identical for all countries, created in English, and translated into the different national languages.

Experiment

An experimental design was used to test the effects of different types of products varying in their percentage of bio-based materials (see Section 2.3). For the experiment we used two examples of applications of bio-based materials (i.e., coke-bottle and shampoo). The first example shows the use of plant materials in bottles of soft drinks. In 2011, The Coca-Cola Company announced to develop a bottle made from renewable plant-based materials. This was the first recyclable PET plastic beverage bottle made partially from plants. The material looks and functions just like traditional PET plastic, but has a lighter footprint on the planet and its scarce resources. Building on the Coca-Cola example, several other multinational companies followed like Heinz and Procter & Gamble by using plant-based materials in their packaging material. The second example is the use of bio-based materials in personal care products (i.e., shampoo). This represents an interesting product category since renewable bio-based materials can be used to replace petroleum based glycols in cosmetic and personal care products. Both products are also selected because the focus groups among consumers (Task 9.1) showed that these products had a higher involvement among the respondents compared to the other products (e.g., WPC decking). These products are in direct contact with oneself, because one drinks (i.e., coke) or touches the product (i.e., shampoo).

Taken together, two features (*percentage of bio-based materials* and *brand*) were used as a basis to create descriptions of the products. As a result, we created a 3x3 experimental design, which leads to the following 9 different descriptions of products:

- Coca-Cola bottle (brand) that contains no bio-based materials;
- Coca-Cola bottle (brand) that contains partially bio-based materials (i.e., 30%);
- Coca-Cola bottle (brand) that contains full bio-based materials (i.e., 100%);
- Coke bottle from your local supermarket (private label) that contains no bio-based materials;
- Coke bottle from your local supermarket (private label) that contains partially bio-based materials (i.e., 30%);
- Coke bottle from your local supermarket (private label) that contains full bio-based materials (i.e., 100%);
- Garnier shampoo (brand) that contains no bio-based materials;
- Garnier shampoo (brand) that contains partially bio-based materials (i.e., 30%);
- Garnier shampoo (brand) that contains full bio-based materials (i.e., 100%).

Each description was accompanied with a picture of the product. We used the following pictures:

Figure 2: Stimulus materials used in experimental design
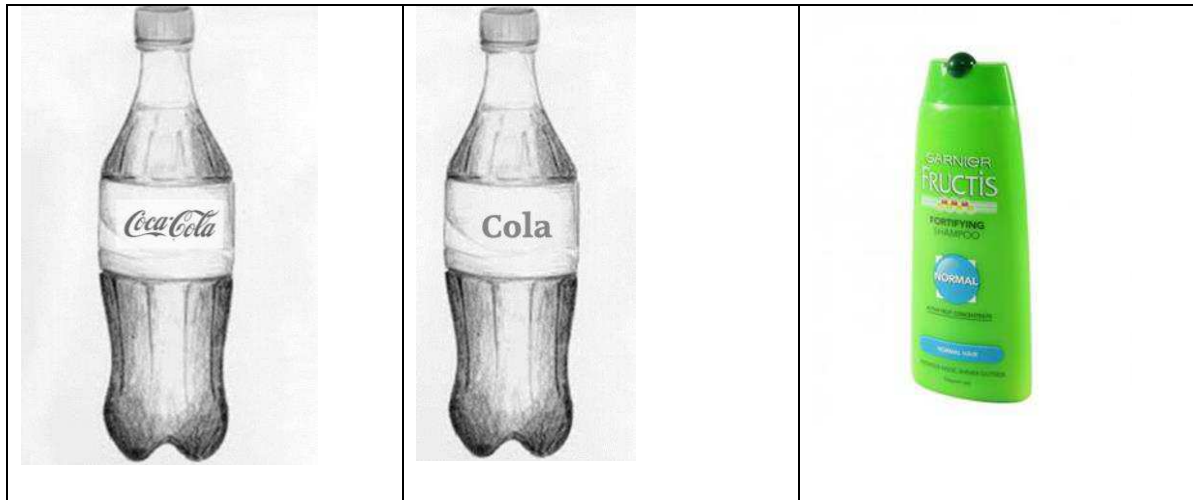
We applied a between-subjects design in which respondents were randomly assigned to one of these 9 conditions of the questionnaire. Each condition, except the condition for the Coca-Cola bottle (brand) that contains partially bio-based materials (see next paragraph for an example), contained approximately 100 respondents per country. For each condition the variables of interest were measured.

Model

To test the model for evaluation of bio-based products as described in Section 2.2, we used one of the experimental conditions as the 'main' condition. Because it is undesirable that the experimental design affects the estimation of our conceptual model, we only selected one of the conditions to estimate our model, namely the condition in which the respondents received the description and picture of the Coca-Cola bottle with 30% bio-based material (condition 2). This condition contained about 200 respondents per country. We decided to use this condition, because this represents the current situation (as this product is currently sold in supermarkets).

3. Knowledge of and associations with bio-based products

3.1. Results

Familiarity with bio-based products.

Table 1 shows how familiar respondents are with bio-based products. The results are shown for each of the six included countries. In general 52.5% of the respondents stated to have heard of bio-based products, but only 21.8% reported to exactly know what bio-based products are. Note that these results might have a positive bias, because individuals have a tendency to overestimate their familiarity with a specific product in aided questions.

Chi-square difference tests reveal differences across countries. The results show that in Denmark and the Netherlands the percentages of respondents who stated to exactly know what bio-based is relatively small (±6%). Italy and Slovenia show the largest percentages of respondents that report to know what bio-based products exactly are (±40%).

Table 1: Familiarity with bio-based products in percentages for each country

	Denmark (N=1011)	*Germany (N=1132)*	*Italy (N=1055)*	*The Netherlands (N=1012)*	*Czech Republic (N=1008)*	*Slovenia (N=1010)*	*Total (N=6228)*
Yes, I know exactly what they are	6.2	23.9	40.9	5.8	13.6	39.5	21.8
Yes, I have heard of it	48.1	49.3	52.5	35.8	71.2	58.8	52.5
No, I have never heard of it	45.7	26.8	6.6	58.4	15.2	1.7	25.6

Open associations with bio-based products.

Respondents were asked to report three types of associations: positive associations, negative associations and associations with specific products. At first with regard to the positive associations, Figure 3 shows that bio-based is positively associated with the environment. Examples of associations are 'environmentally', 'biological', 'ecological', natural'and 'sustainability'. Furthermore, bio-based products are also positively associated with health ('healthy' and 'health').

Figure 3: Wordcloud showing positive associations with bio-based products

Figure 4 shows negative associations with bio-based products. This figure shows that bio-based products are negatively associated with higher costs. For example 'price', 'expensive' and 'cost'. Additionally bio-based products are negatively associated with marketing trics. For example: 'misleading, 'scam', and 'advertising' are mentioned. There are also some negative associations with organic, bio, and low availability. Thus, environmental aspects are both shown as positive and negative associations.

Figure 4: Wordcloud showing negative associations with bio-based products

Figure 5 shows which specific type of products people think of when the are confronted with the term 'bio-based products'. The results show strong associations with food

products, such as 'vegetables', 'fruit', 'milk' and 'meat'. Additionally, 'clothing', 'cosmetics', 'detergents', and 'cleaners' are mentioned relatively often. Finally, respondents also mention organic, indicating that they link bio-based products with organic products.

Figure 5: Wordcloud showing associations with specific products
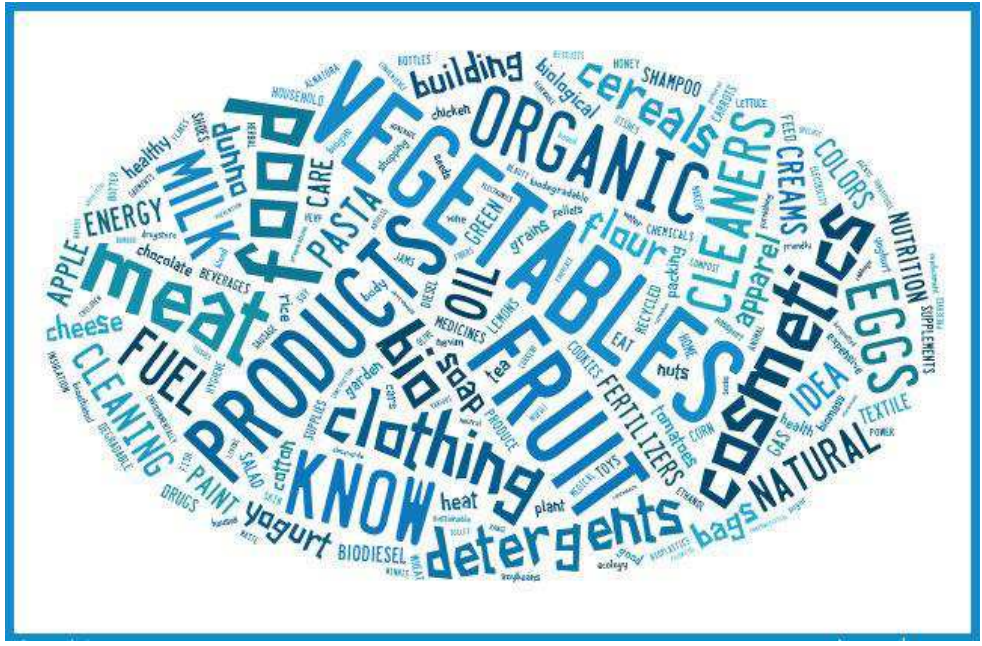
Aided associations with bio-based products.

Table 2 shows the means, standard deviations, and percentage of respondents who did not know what to answer for a range of provided possible associations with bio-based products. The percentage of respondents who reports to 'don't know' is between 10 and 20%. This indicates that these aided associations were difficult to answer for respondents. Especially the items that refer to technology, fair trade, and animal welfare were difficult to answer.

Furthermore, the results in Table 2 show that on average all items are shown to be more positively than negatively associated with bio-based products (mean larger than midpoint of scale = 4), with the exception of price. Thus, bio-based is positively linked to a broad range of terms, such as environment sustainable and innovative. All the mean scores differ significantly from each other. Thus, for example, environment, health, recyclability and naturalness are most positively associated with bio-based products. Although animal welfare is also ranked highly, more than 20% of the respondents indicated that they do not know how they would evaluate bio-based products in relation to this aspect.

Price was assessed more negatively than positively by respondents, indicating that they did not link this attribute to bio-based.

Table 2: Aided associations with bio-based products from positive to negative

	Mean	*SD*	*% Don't Know*
Environment	5.95	1.316	11.35%
Health	5.89	1.308	12.20%
Recyclable	5.84	1.339	13.60%
Naturalness	5.81	1.333	12.60%
Animal welfare	5.69	1.412	20.40%
Sustainable	5.48	1.450	14.50%
Innovative	5.38	1.413	16.60%
Safety	5.37	1.403	17.50%
Energy use	5.25	1.487	17.35%
Traded in a fair way	5.07	1.639	18.30%
High tech	5.01	1.542	20.10%
Technological	4.98	1.505	20.40%
Appearance	4.83	1.427	18.70%
Price	3.58	1.798	14.30%

Note. Items were answered on a 7 point scale (1=negative and 7= positive). The items 'waste' and 'harmful to health' were deleted for further analyses because these two items could be interpreted ambiguously; SD= Standard Deviation.

We checked whether there are differences in these aided associations between countries with a MANOVA. Country was included as independent variable and the aided associations as dependent variables.

The results show that all aided associations differ significantly across countries (Post Hoc Tukey tests)[1]. We can see that Germany, the Netherlands, and Denmark often have the same associations (e.g., traded in a fair way, price, animal welfare, innovative, and sustainable). Italy, Slovenia, and Czech Republic sometimes follow different patterns (e.g., technological, innovative, naturalness, sustainable) and sometimes the same (e.g., animal welfare, recyclable). Generally, all countries positively associate bio-based products the most with the environment, recyclable and naturalness. Though for Italy, Czech and Slovenia Health and safety are relatively more positively associated with bio-based products than Denmark and the Netherlands.

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[1] To control for answering tendencies which might differ across countries, we also performed this test with mean-centered scores (on respondent level). Thus for each reaspondent the mean score for all their Likert scale answers is computed. This mean score is in turn substracted from the aided association scores. The results show comparable findings.

Table 3: Aided associations with bio-based products from negative to positive for each country

	Denmark (N=1011)	Germany (N=1132)	Italy (N=1055)	The Netherlands (N=1012)	Czech Republic (N=1008)	Slovenia (N=1010)
Environment	5.84	5.77	6.25	5.82	6.03	5.93
Recyclable	5.79	5.39	6.10	5.78	6.03	5.91
Naturalness	5.66	5.78	6.21	5.80	5.62	5.74
Sustainable	5.64	5.64	6.01	5.69	5.24	4.67
Health	5.54	5.74	6.20	5.64	5.93	6.15
Animal welfare	5.51	5.51	5.94	5.57	5.78	5.73
Innovative	5.37	5.19	5.83	5.34	5.45	5.06
Energy use	5.35	5.00	5.47	5.26	5.43	5.05
Traded in a fair way	5.30	5.24	5.64	5.44	4.40	4.39
Technological	5.26	4.55	5.38	5.00	5.14	4.62
High tech	5.16	4.35	5.38	4.89	5.37	4.92
Safety	5.12	5.09	5.85	5.25	5.37	5.39
Appearance	4.51	4.89	5.15	4.53	4.90	4.82
Price	3.71	3.52	4.11	3.60	3.50	3.09

Awareness.

Awareness refers to the ability of a buyer to recognize or recall that a product (here bio-based) is a member of a certain product category (Yoo et al., 2000). Table 4 shows that there are significant differences between countries ($F(5, 6227)=262.361$; $p<.001$). Post hoc Tukey tests reveal that all countries differ significantly with the exception of Italy and Slovenia and Germany and Czech Republic. This implies that respondents from Italy and Slovenia are most aware of bio-based products, whereas respondents from Denmark are least aware. This corresponds with the pattern that was found with regard to familiarity with bio-based products: Italy and Slovenia also appeared to be the countries with the highest percentages of respondents that know what bio-based products are (see Table 1).

Table 4: Differences across countries in awareness of bio-based products

	Denmark (N=1011)	Germany (N=1132)	Italy (N=1055)	The Netherlands (N=1012)	Czech Republic (N=1008)	Slovenia (N=1010)	Total (N=6228)
Awareness	2.79	3.50	4.53	3.24	3.66	4.44	3.70

Note. Awareness of bio-based products (1=low awareness and 7=high awareness)

3.2. Conclusions

Familiarity with, and awareness of, bio-based products is mixed and differs across countries. Respondents in Italy and Slovenia are most familiar with these products, and respondents in the Netherlands and Denmark the least.

Bio-based products are most strongly associated with the environment, referring to a broad range of aspects such as recycable, organic, naturalness. These associations with the environment are most often recalled as positive associations, though sometimes also as negative associations.

Health and safety are also relevant associations with bio-based products. Especially in Italy, Czech, and Slovenia.

Technological and fair trade aspects are less often associated with bio-based products.

4. Factors explaining consumer acceptance of bio-based products

4.1. Data preparation and analyses

This paragraph aims to test the hypothesized conceptual model (see Figure 1). Structural equation modelling (with latent variables) was used to test this model because this statistical program allows to include mediating effects (i.e. effects that occur via a third variable: for example the effects of benefits on intentions occur via emotions). The analyses were performed with Mplus version 6.11 on a subset of the dataset (see Method Section 3.2).[2]

To specify whether adding ambivalence to the TPB, as hypothesized, increases the explained variance in consumer acceptance of a novel biobased product, we specified several structural regression models. We distinguish three steps. First, we estimated the vested TPB-model extended with emotions to replicate previous studies in the context of bio-based products. Second, we estimate the hypothesised model (see Figure 1). This model includes ambivalence to explore whether ambivalence affects intentions as proposed. Third, we explore whether adding ambivalence significantly increases the explanatory power of the model by comparing nested models[3].

4.2. Results

This section provides a technical description of the results. See the conclusions text-box right after this section for the interpretation of these results. The analyses thus included three steps. First, we estimated a model including emotions and the TPB. The results show a good model fit (relative chi-square = 4.44; RMSEA = .053; SRMR = .053; CFI = .963; TLI = .959), indicating that the proposed associations are indeed present. This model confirms previous studies showing that intentions are directly affected by risks, norms, perceived behavioural control, and positive and negative emotions. The effects of benefits are fully mediated by positive emotions. The effects of norms and perceived

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[2] We used the following tests. After model estimation several model fit indices are reported. These indices can be interpreted as follows. The relative chi-square equals the chi-square index divided by the degrees of freedom (Kline, 2011). Relative chi-squares of less than 5 indicate adequate model fits, relative chi-squares less than 3 indicate good model fits. A RMSEA of .07 (Steiger, 2007) and a SRMR below .08 indicate a satisfactory model fit (Hu & Bentler, 1999). Finally, CFI and TLI indices of at least .90 indicate a satisfactory model fit (Bhattacherjee, 2002; Hu & Bentler, 1999).
[3] Chi-square difference tests were used to compare the alternative nested models (i.e. models that can be derived by placing restrictions on the more general model).

risks are partially mediated by negative emotions. Finally, perceived behavioural control is mediated by both positive and negative emotions.

Second, the same model as described above was estimated, including ambivalence (see Figure 6). The results show good model fit (relative chi-square = 4.12; RMSEA = .051; SRMR = .052; CFI = .963; TLI = .960), indicating that the proposed associations are indeed present. The model shows that ambivalence has a negative impact on intentions. Additionally, the effects of ambivalence on intentions are mediated by positive emotions (Est .061; $p<.001$) and not by negative emotions (Est .001; $p=.757$).

Third, we aim to ascertain that including ambivalence significantly improves the model. The model in which all associations of ambivalence are restrained to zero (relative chi-square = 4.97; RMSEA = .057; SRMR = .133; CFI = .953; TLI = .949) has a significantly lower model fit compared to the model that allows ambivalence to affect intentions ($\Delta df=7$; $\Delta\chi2=638.89$; $p<001$). This indicates that ambivalence indeed shows an improvement to the model. The explained variance of intentions increases with 2% by adding ambivalence to the model (form 58% to 60%).

Figure 6: Model showing factors that explain intention to buy bio-based products
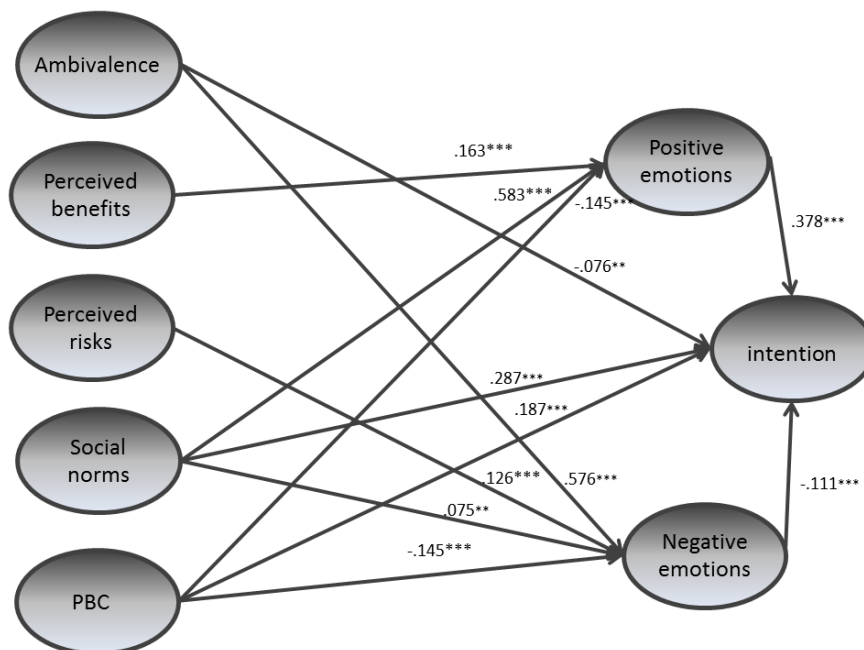
In this paragraph we explored whether the associations between risks, benefits, and ambivalence with intentions are stronger for specific individuals compared to others. This allows us to have an idea for which individuals these effects are stronger. The results are shown in Table 5 Below we provide a short description of the implications of the significant results.

- The results imply that the relationship between perceiving risks and intentions (i.e, individuals who see many risks of bio-based products are less inclined to buy

these products) is less strong for individuals who think to know more about bio-based products and are more innovative in the domain of buying products. This implies that individuals who know more are less affected by perceived risks. Possibly individuals that have more (self-perceived) knowledge have a tendency to see the whole picture and for example place risks besides benefits.

- The effects of perceived benefits on intentions are enhanced for individuals who think they know more about bio-based products (subjective knowledge), who relatively care more about their own safety (safety orientation) or the environment (personal norms).

- Finally, the effects of ambivalence on intentions are less strong for individuals that care about the environment (personal norm). This implies that individuals that value the environment and feel obligated to follow their norms are less inclined to use mixed feelings to form intentions.

Table 5: Moderating effects: is the conceptual model different for different personalities?

	Intention-Risk	*Intention-Benefit*	*Intention-ambivalence*
Subjective knowledge	-	+	n.s.
Domain Specific innovativeness	-	n.s.	n.s.
Safety Orientation	n.s.	+	n.s.
Personal Norms	n.s.	+	-

Note. -= negative interaction effect; += positive interaction effect; n.s.= non significant interaction effect. There were no significant interaction effects for health orientation

4.3. Conclusions

In accordance with previous studies, intention to buy bio-based products is explained by:
- Risks and benefits: the perceived risks and benefits of bio-based products.
- Social norms: whether one believes that friends and family wants them to buy bio-based products.
- Perceived behavioural control: whether one believes that one is able to buy bio-based products (e.g., for example available in store).

We show that the effects of social norms, risks and benefits, and perceived behavioural control are mediated by emotions. Thus, these factors affect intentions because they make individuals experience positive or negative emotions.

- Perceived benefits affect intentions via positive emotions (and not via negative emotions). Thus, individuals that perveive relatively many benefits of bio-based products also expect to experience more happiness, pride, and excitement when buying these products. These emotions in turn result in an increased intention to buy bio-based products.

- Perceived risks affect intentions via negative emotions (and not via positive emotions). Thus individuals that perveive relatively many risks of bio-based products also expect to experience more anger, worry, sadness and guilt when buying these products. These emotions in turn result in a decreased intention to buy bio-based products.

- The perception of what other people think you should do (i.e., social norm) affects both positive and negative emotions. Though the effects are much stronger for positive emotions. Thus, perceptions of opinions of other people mainly affect intentions because it makes individuals feel good.

- Perceived behavioural control affects intentions via both positive and negative emotions. The results show that individuals who perceive to have more control on buying bio-based products experience less positive and less negative emotions. This finding indicates that individuals who feel less in control regarding buying bio-based products are more prone to rely on emotions (both positive and negative), whereas individuals who feel more in control are more prone to rely on conscious deliberations.

Finally, and most relevant, the results show that adding ambivalence to the conceptual model further increases the explained variance of the intention to buy bio-based products. Thus ambivalence increases the understanding of how intentions towards bio-based products are formed. Individuals who experience mixed feelings towards bio-based products are less prone to buy bio-based products.

- Ambivalence also affects intentions via emotions. Individuals that experience mixed feelings experience more negative emotions (and not positive emotions). These emotions in turn result in a decreased intention to buy bio-based products.

The results thus show that the intention to buy bio-based products is not just a cognitive deliberation, emotions also play a role in forming intentions. Additionally, we show that besides perceptions of risks and benefits individuals can also experience ambivalence (they just don't know what to think).

5. Experiment with different types of bio-based products

5.1. Data preparation and analyses

Using an experimental design, we test the effect of adding bio-based attributes on consumers' evaluation of a brand (i.e., global brands versus private labels) as well as whether different percentages of bio-based (i.e., no bio-based bottle, 30% bio-based bottle and 100% bio-based bottle). MANOVA was conducted with positive and negative emotions and buying intentions as dependent variables and the 3 percentages of bio-based, the 3 products (i.e., Coca-Cola bottle, store brand coke bottle and Garnier shampoo) and the 6 countries as factors. In this section, we focus on intentions and positive and negative emotions because these variables provide implications regarding consumer acceptance.[4]

Since one of the conditions has approximately 200 respondents per country, we first drew a random sample of 50% of these respondents to use in the analyses for the experiment. Consequently, this sample was comparable in size to the other experimental conditions.

5.2. Results

The results provide a technical description of the results. See the conclusions text-box right after this section for the interpretation of these results.

Positive and negative emotions

The results reveal that positive and negative emotions and buying intention differ across the 3 bio-based levels (see Table 6). Furthermore, positive and negative emotions and buying intention differ significantly across the 3 products and the 6 countries. Significant interactions between bio-based level and product are reported for positive emotions and buying intention. Furthermore, significant interactions between bio-based level and country as well as significant interactions between product and country are reported for all variables.

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[4] We also tested the effects of the experimental conditions on the explanatory variables of the hypothesized model (Figure 1): perceived benefits, perceived risks, social norms, perceive behavioural control, and ambivalence. We refer to Appendix C for a description of these results.

Table 6: Estimated marginal means for emotions and buying intention for all countries

		Positive emotions	*Negative emotions*	**Buying intention**
Bio-based level				
Non bio-based (*N*=1875)		2.75[a]	2.62[a]	3.24[a]
Partly bio-based (*N*=1868)		3.31[b]	2.29[b]	3.76[b]
Full bio-based (*N*=1871)		3.61[c]	2.18[b]	4.12[c]
Product				
Coca-cola bottle (*N*=1871)		3.15[a]	2.48[a]	3.64[a]
Store brand coke bottle (*N*=1870)		3.14[a]	2.55[a]	3.51[a]
Garnier shampoo (*N*=1873)		3.37[b]	2.06[b]	3.96[b]
Country				
Denmark (N=915)		3.05[a]	2.44[a,b]	3.33[a]
Germany (N=1030)		3.38[b]	2.32[a,b]	3.93[b]
Italy (N=934)		4.07[c]	2.40[a,b]	4.64[c]
The Netherlands (N=916)		3.01[a,d]	2.22[a]	3.35[a]
Czech Republic (N=908)		3.00[a,d]	2.30[a,b]	3.70[b]
Slovenia (N=911)		2.83[d]	2.50[b]	3.28[a]
Main effect Bio-based level	*F*	146.66***	39.21***	39.80***
	(df1,df2)	(2, 5560)	(2, 5560)	(2, 5560)
	Partial η^2	.050	.014	.014
Main effect Product	*F*	13.25***	52.21***	42.54***
	(df1,df2)	(2, 5560)	(2, 5560)	(2, 5560)
	Partial η^2	.005	.018	.015
Main effect Country	*F*	76.83***	3.77**	12.78***
	(df1,df2)	(5, 5560)	(5, 5560)	(5, 5560)
	Partial η^2	.065	.003	.011
Main effects Bio-based level*Product	*F*	7.65***	2.22	2.85*
	(df1,df2)	(4, 5560)	(4, 5560)	(4, 5560)
	Partial η^2	.005	.002	.002
Main effects Bio-based level*Country	*F*	3.40***	1.89*	3.44***
	(df1,df2)	(10, 5560)	(10, 5560)	(10, 5560)
	Partial η^2	.006	.003	.006
Main effects Product*Country	*F*	6.46***	5.54***	4.27***
	(df1,df2)	(10, 5560)	(10, 5560)	(10, 5560)
	Partial η^2	.011	.010	.008
Main effects Bio-based level*Product*Country	*F*	1.41	.61	.42
	(df1,df2)	(20, 5560)	(20, 5560)	(20, 5560)
	Partial η^2	.005	.002	.002

*Notes: Answer scales ranged from 1 to 7; Means with a different superscript (a, b, c) indicate a significant difference (p < .05) (means are compared two at a time); *** p < .001; **p < .01; *p < .05.*

An inspection of the means of the bio-based levels demonstrates that the full (100%) bio-based product had the highest scores on positive emotions and buying intention, followed by the partly (30%) bio-based option. The non bio-based option showed the lowest scores. In contrast, the full (100%) bio-based product showed the lowest scores on negative emotions and the non bio-based option showed the highest scores. Bonferroni post-hoc tests showed that all means of the 3 bio-based levels are significantly different from each other ($p < .05$). However, for negative emotions, Bonferroni post-hoc tests demonstrate that the full (100%) bio-based product did not differ significantly from the partly (30%) bio-based product. Instead, both bio-based conditions were significantly different from the non bio-based option ($p < .05$): negative emotions were lower for the bio-based products as compared to the non bio-based products.

When looking at the means of the different products, Garnier shampoo was rated highest in terms of positive emotions and lowest in terms of negative emotions. Garnier shampoo was also rated significantly higher on buying intention than Coca-Cola and store brand cola. Coca-Cola and the store brand coke did not significantly differ in terms of positive emotions and negative emotions and buying intention.

Finally, when looking at the means of the different countries, Italy had the highest scores and Slovenia had the lowest scores on positive emotions and buying intention. Generally, the countries differed not much in their scores on negative emotions. The Netherlands had the lowest score on negative emotions.

When looking at the significant interaction effects between bio-based levels and products for positive emotions and buying intentions, Figure 7 below showed the patterns for the different products for the different bio-based levels:

- It seems that the positive effect of bio-based on positive emotions is more pronounced for the coke bottles as compared to the Garnier shampoo. When comparing Coca-Cola and the store brand cola, it looks like the positive effect of bio-based is somewhat more pronounced for store brand cola, especially between the no bio-based and the 30% bio-based conditions.

- Similarly, it looks like the positive effect of bio-based on buying intention is more pronounced for the coke bottles as compared to the Garnier shampoo (which is comparable to the tendencies for the other variables as we saw earlier). When comparing Coca-Cola and the store brand cola, it looks like the positive effect of bio-based on buying intention is somewhat more pronounced for store brand cola, especially between the non bio-based and the 30% bio-based conditions.

Figure 7: Interaction effects between level of bio-based and products on positive emotions, ambivalence and buying intention
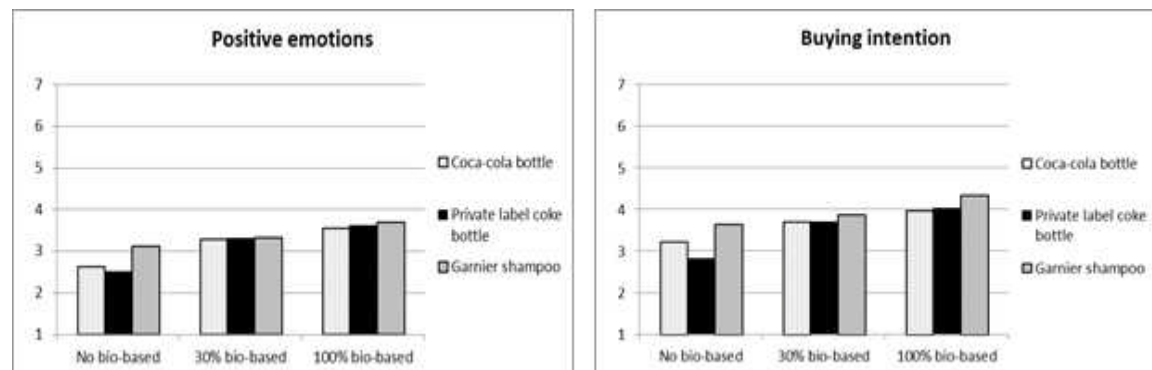
Note. Negative emotions are not shown as these interaction effects were non-significant

Role of personal characteristics

In addition to the interactions between the different bio-based levels with different percentages of bio-based materials and the different products/ brands, we also checked whether personal characteristics play a role in the evaluation of the different products. Therefore, we distinguished between respondents with low and high scores on the various personal characteristic variables based on the sample median.

Table 7 displays the interaction effects between level of bio-based (no bio-based/ 30% bio-based/ 100% bio-based) and personal characteristics (divided into the degree to which respondent possesses a specific characteristic: high/ low). Significant interaction effects between bio-based level and personal characteristics were found for all variables.

- The effect of bio-based was more pronounced for respondents exhibiting higher levels of subjective knowledge. Especially the difference in scores between the no bio-based and the 30% bio-based condition was higher for respondents who possess higher levels of subjective knowledge;

- The effect of bio-based was also more pronounced for respondents exhibiting higher levels of domain-specific innovativeness. Again, the difference in scores between the no bio-based and the 30% bio-based condition was higher for respondents who possess higher levels of domain-specific innovativeness;

- The effect of bio-based was also more pronounced for respondents exhibiting higher levels of health orientation. Again, the difference in scores between the no bio-based and the 30% bio-based condition was higher for respondents who possess higher levels of health orientation;

- Finally, the effect of bio-based was more pronounced for respondents exhibiting higher personal norms (i.e., those people that feel a higher moral obligation to protect the environment). For positive emotions and buying intention, especially the increase in scores between the 30% bio-based and the 100% bio-based

condition was higher for respondents with high personal norms, whereas for negative emotions, the decline in scores between the no bio-based and the 30% bio-based condition was higher for respondents with high personal norm.

Table 7: Moderating effects: is the effect of the different percentages of bio-based different for different personalities?

	Positive emotions	*Negative emotions*	*Buying intention*
Subjective knowledge	+	-	+
Domain-specific innovativeness	+	-	+
Personal orientation: health orientation[5]	+	-	+
Personal Norms	+	-	+

Note. -= negative interaction effect; += positive interaction effect; n.s.= non-significant interaction effect.

5.3. Conclusions

The percentage of bio-based materials has a positive effect on positive emotions and buying intention and a negative effect on negative emotions. Repondents prefer to buy products that consist of 100% bio-based materials. However, notice that consumers' buying intention is also significantly higher for products that are partly based on bio-based materials as compared to products that do not use bio-based materials.

This effect seems to be more pronounced for the store brand cola, and less pronounced for the shampoo. An inspection of the interaction effects between percentage of bio-based materials and type of brand revealed that the difference in scores between no bio-based and partly bio-based is higher for the store brand than for the national brands. This implies that the store brand could profit most from introducing partially bio-based products in their assortment.

Also differences between countries are reported. Generally, Italy showed the highest scores on positive emotions and buying intention, whereas Slovenia showed the lowest scores on these variables.

The personality traits that we incorporated in this study strengthen the effect of bio-based on the scores on emotions and buying intention.

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[5] Notice that next to health orienation we also incorporated safety orientation as a personal characteristic in this study. We found similar results as for health orientation.

6. Communication and labelling of bio-based products

6.1. Data preparation and analyses

Similar to paragraph 5.2 the analyses in this paragraph are performed on a subsection of the sample. For paragraph 6.2 we used descriptive analyses and ANOVAs. These tests are described below.

Paragraph 6.3 describes a choice question in which respondents had to indicate which option of paint (i.e., *No bio-based paint*, *Bio-based paint without labels*, *Bio-based paint with European Ecolabel* and *Bio-based paint with Biodegradable label*) they would choose with regard to a number of product benefits. Apart from frequency analyses to check what option is preferred for which product benefit, we looked at possible determinants of respondents' choice behaviour with regard to the different bio-based paint options. In addition, we looked how respondents' choices differ across the countries. Multinomial logistic regressions were employed to estimate the impact of the different personal characteristics on the choice options for bio-based products. The dependent variable was categorical, and we used the mean scores on the personal characteristics to compute the probability of making a certain choice. Furthermore, cross-tabulation in combination with Pearson Chi-square analyses were conducted to check for potential interactions between the different bio-based paint options and country.

6.2. Results

Information that should be communicated.

Respondents were asked to select a maximum of three items from a list of 14 possible communication contents. Per country the highest percentage is highlighted in green and the second highest percentage is highlighted in yellow.

Overall the results show that the most preferable information concerns health impact for Italy, Czech Republic, and Slovenia. Recyclability and biodegradability received high percentages for all countries. These findings correspond with the associations that people have with bio-based products as presented in Table 3 This table shows that health, environment and recyclable are most positively associate with bio-based products. Furthermore, Table 8 shows that compostability seems to be relatively important in Denmark. Social impact and product functionalities are examples of information which are relatively unimportant for all countries.

Table 8: Percentages of respondents that indicated to favour the information (green= highest %; yellow=second highest %)

	Denmark (N=193)	Germany (N=224)	Italy (N=212)	The Netherlands (N=189)	Czech Republic (N=200)	Slovenia (N=200)	Total (N=1227)
The percentage of bio-based	16.1	26.8	17.0	17.2	19.0	14.0	18.5
CO2 footprint of the product	23.8	16.1	31.1	14.6	7.0	6.5	16.6
Environmental impact of product's life-cycle	24.4	22.3	28.3	25.8	3.5	21.0	20.9
Environmental impact of the raw material	18.7	26.3	27.8	29.8	6.5	24.5	22.4
Health impact (benefits)	32.1	32.1	37.7	26.8	60.0	76.0	43.9
Safety impact (benefits)	15.5	9.4	13.7	12.6	24.5	24.0	16.5
Product functionalities	6.7	9.4	12.7	5.1	25.5	17.0	12.7
Compostability	36.8	21.0	11.3	15.7	13.5	15.5	18.8
Energy saving	20.7	19.2	25.5	21.2	25.5	24.0	22.7
Recyclability	40.9	36.2	33.5	46.5	55.0	31.0	40.3
Biodegradability	26.4	30.4	33.5	37.9	30.0	36.0	32.4
Social impact of production	5.7	8.9	11.3	7.1	5.5	7.5	7.7
Other, please specify: ...	1.6	0.9	0.0	2.0	0.5	0.0	0.8
No communi-cation at all	3.6	10.3	1.9	8.1	5.0	0.5	5.0

Evaluation European Ecolabel.

Table 9 shows the means of the evaluation of the European Ecolabel for each country. ANOVAs reveal that the evaluation of the European Ecolabel differs significantly across countries. A detailed look at Post Hoc Tukey tests reveals that the label is perceived different in Italy compared to the other countries. Italian respondents are more positive towards the label and they more agree that the Ecolabel is a well-known label. Additionally, the Netherlands and Denmark show to have a comparable perception of the label. Czech Republic, Slovenia, and Germany also have comparable perceptions of the label. Thus, Italian respondents are most positive, followed by Czech, Slovenian, and German respondents. Dutch and Danish respondents are least positive.

Table 9: Mean scores Evaluation European Ecolabel

	Denmark (N=193)	Germany (N=224)	Italy (N=212)	The Netherlands (N=198)	Czech Republic (N=200)	Slovenia (N=200)	Total (N=1227)
The EU Ecolabel is a well-known label for consumer products	3.54	3.86	4.87	3.25	3.52	3.77	3.82
The EU Ecolabel is a trustworthy label for consumer products	3.88	4.30	5.31	3.40	4.15	4.22	4.28
The EU Ecolabel informs me well about the environmental aspects of the products	3.28	4.38	5.15	3.48	3.90	4.02	4.06
The EU Ecolabel informs me well about the quality aspects of the products	3.44	3.82	5.08	3.34	3.92	4.04	3.95

Note. A 7-point Likert scale from 1 (totally disagree) to 7 (totally agree) was used

Trust in information sources.

Table 10 shows the mean scores of how respondents trust a range of difference information sources that might communicate over bio-based products. ANOVAs reveal that there are country differences in trustworthiness of information sources for all included stakeholders, except for consumer organisations. Information from consumer organisations was perceived to be most reliable across countries. Then, NGOs are most trustworthy for Denmark, Germany, and Italy. Certifying organisations are most trustworthy in the Netherlands, Czech republic, and Slovenia. Television programs, newspapers, government, and manufacturers are less trustworthy in all countries.

Table 10: Means of trust in information sources across countries

|	Denmark (N=193)	Germany (N=224)	Italy (N=212)	The Netherlands (N=198)	Czech Republic (N=200)	Slovenia (N=200)	Total (N=1227)
Family and friends	3.99	4.07	4.46	4.04	4.36	4.60	4.25
Television programs	3.87	3.79	3.98	3.94	3.79	3.43	3.80
Newspapers and magazines	3.56	3.89	4.24	3.81	3.78	3.53	3.81
Internet	3.74	4.20	4.64	4.23	4.40	4.20	4.24
Government/ governmental agency	4.27	4.05	4.18	4.30	3.39	3.11	3.89
NGOs (e.g., WWF, Greenpeace)	4.53	4.88	5.25	4.46	4.58	4.59	4.73
Consumer organisations	5.06	5.04	5.31	4.89	4.98	4.94	5.04
Manufacturer/ supplier	3.56	3.97	4.57	3.76	4.30	3.85	4.01
Independent certifying organization	4.28	4.63	5.12	4.76	4.76	4.68	4.71

Note. A 7-point Likert scale from 1 (very unreliable) to 7 (very reliable) was used. ; green=highest; yellow=second highest; light-yellow=third highest.

Choice question regarding bio-based paint

Figure 8 below shows how often the different bio-based paint options are chosen with respect to different product benefits. As can be seen in the Figure, the bio-based paint with biodegradable logo is most often chosen irrespective of the product benefit. The bio-based paint with the European Ecolabel is the second preferred option for all product benefits. Strikingly, respondents prefer the no bio-based paint above the bio-based paint (without labels) when it comes to quality and attractiveness (although differences are very small for the latter). Buying preference is almost equal between the no bio-based paint and the bio-based paint (without labels). One critical note that should be mentioned here is that an order effect may have potentially biased the results. Respondents may have deducted from the way the different options were presented in the questionnaire, that the bio-based paint with biodegradable logo was the 'best' option followed by the bio-based paint with Ecolabel.[6]

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[6] Additionally, we checked whether the different experimental conditions of the previous part of the questionnaire could have influenced the outcomes of the choice question. Stated differently, respondents who received an experimental condition with a 100% bio-based product could choose differently than respondents who received a no bio-based product. Analyses showed no significant differences between the different experimental conditions, except for the choice for the most environmentally friendly (Pearson $\chi2 = 39.08$, $p < .05$). However, cross-tabulation of the different experimental conditions with the different choice options revealed no clear pattern.

Figure 8: Distribution of respondents over the different label options for bio-based paint
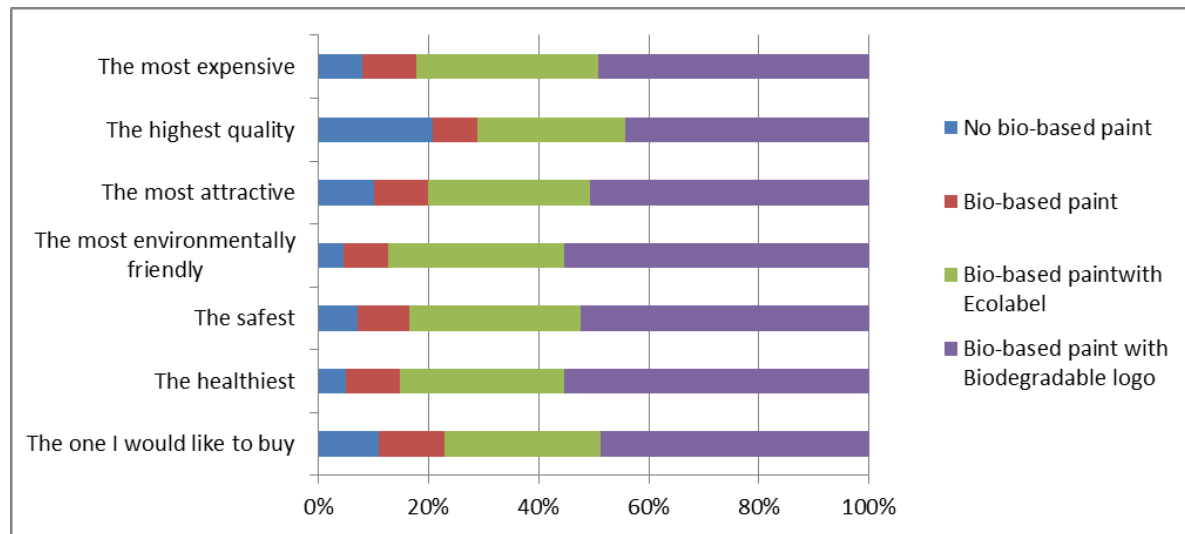
Interaction with countries

Pearson Chi-square analyses revealed significant differences between countries for all variables ($p < .05$). Figure 9 shows the differences across countries in their buying preferences for the different bio-based paint options. Germany showed the highest buying preference for the no bio-based paint in comparison to the other countries, and Italy is the lowest. In addition, in comparison to the other countries the respondents from Czech Republic are most likely to select the bio-based paint without labels as the one they would like to buy. The percentages of bio-based paint with Ecolabel do not show large differences between the countries. Finally, Slovenia is most likely to show the highest buying preference for the bio-based paint with Biodegradable label in comparison to the other countries and Czech Republic is apparently less likely to choose this option.

Figure 9: Likelihood of choosing one of label options for bio-based paint
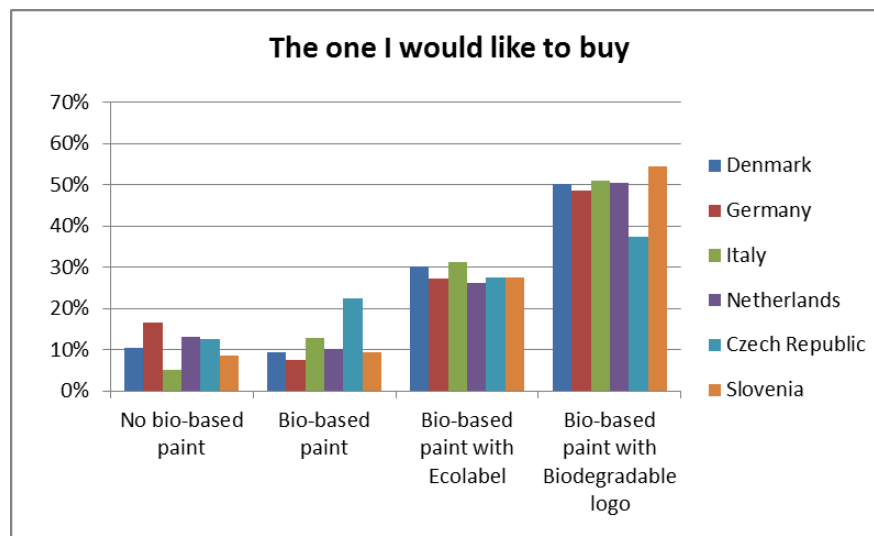
Determinants of choice: Multinomial logistic regression

As indicated, multinomial logistic regressions were employed to estimate the impact of the different personal characteristics on the buying preference for the different bio-based paint options. The dependent variable was categorical, and we used the mean scores on the personal characteristics to compute the probability of making a certain choice. Table 11 reports the results. Tests for the overall effect of the predictor variables are outputted by likelihood ratio tests. The logistic regression showed a significant model fit ($p < .001$).

- Understanding of bio-based, domain-specific innovativeness and personal norm to protect the environment are significant in distinguishing no bio-based paint from bio-based paint with Biodegradable label. Respondents with higher understanding of bio-based, a higher domain-specific innovativeness and a higher personal norm are less likely to choose no bio-based paint than the paint with biodegradable logo.

- In addition, understanding of bio-based, subjective knowledge and personal norm to protect the environment are significant in distinguishing bio-based paint from bio-based paint with Biodegradable label: respondents with a higher understanding of bio-based and higher personal norm are less likely to choose bio-based paint than the paint with Biodegradable logo. In contrast, respondents with a higher subjective knowledge are more likely to select bio-based paint as compared to the paint with Biodegradable logo.

- Finally, subjective knowledge is significant in distinguishing bio-based paint with Ecolabel from bio-based paint with Biodegradable label: respondents with a higher subjective knowledge are more likely to select bio-based paint with Ecolabel as compared to the paint with Biodegradable logo.

Table 11: Results multinomial logistic regressions

	Dependent variable	Independent variables	B	Wald	Exp (B)
The one I would buy	Probability No bio-based paint (as compared to bio-based paint with Biodegradable logo)	Understanding of bio-based	-0.15*	5.49	.86
		Subjective knowledge	0.08	0.67	1.09
		Domain-specific	-0.35***	14.13	.71
		Health orientation	-0.21	3.85	.81
		Safety orientation	-0.03	0.09	.97
		Personal norm	-0.45***	19.27	.64
	Probability Bio-based paint (as compared to bio-based paint with Biodegradable logo)	Understanding of bio-based	-0.12*	4.23	.89
		Subjective knowledge	0.25**	8.95	1.29
		Domain-specific	-0.09	1.25	.91
		Health orientation	-0.19	3.64	.82
		Safety orientation	0.05	0.21	1.05
		Personal norm	-0.32**	9.81	.73
	Probability Bio-based paint with Ecolabel (as compared to bio-based paint with Biodegradable logo)	Understanding of bio-based	-0.08	3.75	.92
		Subjective knowledge	0.12*	4.33	1.13
		Domain-specific	0.05	0.77	1.05
		Health orientation	0.00	0.00	1.00
		Safety orientation	-0.07	1.08	.93
		Personal norm	-0.12	2.46	.89

Model fit: χ^2 (df=18) = 182.30, -2 Log Likelihood = 2706.49, $p < .001$

6.3. Conclusions

There is only a small body of respondents indicating they would prefer to see no information at all on bio-based products (<5%). The other respondents all report to prefer to receive information on recyclability and biodegradability. Respondents from all countries would like to receive information on how bio-based products are decomposed or recycled. The results also show some differences between countries. Italy, Czech Republic and Slovenia, who are earlier shown to associate bio-based product more with health impact, also prefer to see relatively more health information.

The EU Ecolabel is evaluated neutral to positive. Though there are differences across countries. Italian respondents are most positive, followed by Czech, Slovenian, and German respondents. Dutch and Danish respondents are least positive.

Although there were small differences across countries, the trustworthiness of information sources shows a comparable ranking across countries. Information from consumer organisations was perceived to be most reliable across countries. For all countries, NGO's (especially in Denmark, Germany, and Italy) and independent certifying organisations (especially in the Netherlands, Czech Republic, and Slovenia) were also highly trustworthy. In contrast, television programs, newspapers, government and manufacturers were less trustworthy.

To test the added value of labelling, we presented a question to the respondents in which they have to choose for different options of bio-based paint, with or without labels. The results revealed that the option with Biodegradable logo is most often selected. The bio-based paint with Ecolabel is the second preferred option for all product benefits. The paint options with the labels showed also the highest buying preference among respondents. There are some country differences. The effect is for example less pronounced for Czech Republic.

Logistic regression analyses showed that especially someone's personal norm to protect the environment plays a role in choosing bio-based products with labels. Interestingly, subjective knowledge seems to have an adverse effect: respondents with a higher subjective knowledge are more likely to select bio-based paint without a label as compared to the paint with Biodegradable logo.

7. Conclusions and recommendations

In this chapter we will describe the main conclusions pertaining to each of the formulated research questions (see Chapter 2). In addition, we will formulate some limitations and directions for future research. This chapter closes with recommendations.

7.1. Discussion of key findings acceptance

What associations do consumers have related to bio-based products and what is consumer's familiarity with bio-based products?

To answer this research question, respondents completed questions regarding their familiarity and associations with bio-based products. Both open and closed questions were used to uncover consumers' associations. The results show that bio-based products are most strongly associated with the environment, referring to a broad range of aspects such as recyclable, organic, and naturalness. These associations with the environment are most often recalled as positive associations, though sometimes also as negative associations. Health and safety are also relevant associations with bio-based products, especially in Italy, Czech, and Slovenia. Strikingly, animal welfare is also positively associated with bio-based. Together with the fact that health is also highly associated with bio-based products, these findings may imply that consumers confuse the term bio-based with organic, natural or sustainable, or that they at least aggregate all these terms   together. This also corresponds with the results of the focus group discussions (see deliverable 9.1), where the words 'bio' and 'based' raised questions and assumptions that the products are partially bio or organic. Technological and fair trade aspects are less often associated with bio-based products.

In addition, the results show that bio-based is often associated with food products, such as 'vegetables', 'fruit', 'milk' and 'meat'. Additionally, 'clothing', 'cosmetics', 'detergents', and 'cleaners' are mentioned relatively often. In this context, consumers also mention organic, indicating that they link bio-based products with organic products. Also the fact that a lot of food products are mentioned as products that are associated with bio-based products implies that they may have confused the terms bio-based and organic.[7] So, together with the fact that consumers associate bio-based products with health and

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[7] To get more insight in the differences between respondents who provided an 'incorrect' answer to the question with which products they associate bio-based products (i.e., consumers who associated bio-based products with food like vegetables, fruit or meat) and respondents who provided a 'correct' answer (i.e., consumers who associated bio-based products with products like detergents, cosmetics of fuel), we performed additional analyses. We refer to Appendix D for a description of these analyses. Note that the results should be interpreted with care, because we did not directly ask respondents what bio-based products are, or for example included true or false questions to discover incorrect associations, but instead asked for associations.

animal welfare, this indicates that consumers may confuse different terms that look similar, but in reality have different meanings.

Finally, familiarity with, and awareness of, bio-based products is mixed and differs across countries. Consumers in Italy and Slovenia report to be the most familiar with bio-based products, and consumers in the Netherlands and Denmark are least familiar. Although these differences in familiarity may partially be due to the fact that consumers may have confused the word bio-based with more well-known terms like organic or biological, these findings at least indicate differences across countries. For example, the relative high awareness with the term bio-based in Italy could be explained by the fact that recent legislation enforces companies to discontinue the use of traditional single-use plastic bags in favor of bioplastic bags or other alternatives. This caused a lot of publicity about the concept of bio-based in that country, thereby raising consumers' awareness. Further research should further disentangle misconceptions and awareness to elucidate these answers. We come back to this aspect in Section 5.2.

Anyhow, people's associations and familiarity with bio-based has consequences for the positioning of bio-based products. The fact that consumers have certain expectations of bio-based products that cannot be met, for example associations with health, may entail a great risk for marketing these products. Especially when current terminologies are feeding these expectations even more. So, marketers should be very cautious in how to communicate and market bio-based products and the extent to which these products could piggyback on current sustainability trends.

To what extent does the developed attitudinal model (including ambivalence and positive and negative emotions) explain consumers' intention to buy bio-based products?

To test the attitudinal model for evaluation of bio-based products, we asked respondents questions regarding the factors that determine acceptance of bio-based products. Structural equation modelling was used to test this model. The results of this consumer study show that intentions to buy bio-based products is in accordance with previous studies explained by:

- Risks and benefits: the perceived risks and benefits of bio-based products;

- Social norms: whether one believes that friends and family wants them to buy bio-based products;

- Perceived behavioural control: whether one believes that one is able to buy bio-based products (e.g., for example available in store).

In addition, we showed that the effects of social norms, risks and benefits, and perceived behavioural control are mediated by emotions. Thus, the results show that the intention to buy bio-based products is not just a cognitive deliberation, emotions also play a role in forming intentions. This has implications for the positioning of bio-based products. Note that experimental designs to explore the impact of different communication messages are necessary to show how different position strategies affect consumer intentions and

behaviour. Nevertheless, the current study does show first implications regarding the position of bio-based products. More specifically:

- Perceived benefits solely affect intentions via positive emotions. Thus, individuals that perveive relatively many benefits of bio-based products also expect to experience more happiness, pride,and excitement when buying these products. These emotions in turn result in an increased intention to buy bio-based products. As a result, it is recommended to maximize the perceived benefits of bio-based products in order to stimulate positive emotions.

- Perceived risks solely affect intentions via negative emotions. Thus, individuals that perveive relatively many risks of bio-based products also expect to experience more anger, worry, sadness and guilt when buying these products. These emotions in turn result in a decreased intention to buy bio-based products. This finding indicates the relevance of minimizing perceived risks of bio-based products in order to reduce negative emotions.

- The perception of what other people think you should do (i.e., social norm) affects both positive and negative emotions. Though the effects are much stronger for positive emotions. Thus, perceptions of opinions of other people mainly affect intentions because it makes individuals feel good. This implies that when making use of social norms in the communication of bio-based products, norms that enhance positive emotions (e.g., via positive framing of the message) are most effective.

- Perceived behavioural control affects intentions via both positive and negative emotions. The results show that individuals who perceive to have more control on buying bio-based products experience less positive and less negative emotions. This finding indicates that individuals who feel less in control regarding buying bio-based products are more prone to rely on emotions (both positive and negative), whereas individuals who feel more in control are more prone to rely on conscious deliberations. So, if companies want consumers to rely less on their emotions when making a decision whether or not to buy their products, they should enhance their customers' feelings of control. For example, by developing a forum such that consumers can provide feedback (i.e. might result in a feeling of control), by clearly explaining what the concept of bio-based is, and how consumers can find or buy these products. Though many questions remain. It is for example not yet clear whether it is more prosperous to let consumers decide via cognitive or emotional deliberations.

Finally, and most relevant, besides perceptions of risks and benefits individuals can also experience ambivalence or mixed feelings (they just do not know what to think). The results of this study show that adding ambivalence to the conceptual model further increases the explained variance of the intention to buy bio-based products. Thus ambivalence increases the understanding of how intentions towards bio-based products are formed. Individuals who experience mixed feelings towards bio-based products are

less prone to buy bio-based products. Ambivalence also affects intentions via emotions. Individuals that experience mixed feelings experience more negative emotions. These emotions in turn result in a decreased intention to buy bio-based products. Based on this finding, it is recommended to minimize ambivalence towards bio-based products in order to reduce negative emotions.

What is the effect of bio-based on brands: Can the use of bio-based materials upgrade a brand? And does this differ between global brands and private label brands?

An experimental design was used to test the effects of introducing bio-based for different types of products and brands. For the experiment we used two examples of applications of bio-based materials (i.e., coke-bottle and shampoo) as well as two global brands (Coca-Cola and Garnier shampoo) and one store brand (store brand coke). The results of this study show that introducing bio-based materials enhances the evaluation of the product. We found that the use of bio-based materials has a positive effect on positive emotions and buying intention and a negative effect on negative emotions towards the product. We found consistent effects across the three products (Coca-Cola, store brand cola and Garnier shampoo) and across the six countries in which this research was conducted. The positive effect of introducing bio-based products seems to be more pronounced for the store brand cola as compared to Coca-cola. This implies that store brands could profit more from introducing bio-based products in their assortment as compared to national brands. Further research should help to further generalize these findings beyond the three brands we used in this study.

Does the percentage of bio-based materials (i.e., 0%, 30% or 100%) matter for the evaluation of the product?

In the experimental study, conditions vary also in the percentage of use of bio-based materials. The percentage of bio-based materials has a positive effect on positive emotions and buying intention and a negative effect on negative emotions towards the product. Consumers prefer to buy products that consist of 100% bio-based materials, however, their buying intention is also significantly higher for products that are partly based on bio-based materials as compared to products that do not use bio-based materials. These results imply that introducing bio-based materials already could help to enhance the value of a product, regardless of the degree to which bio-based materials are used in the product. When introducing bio-based products, companies should be aware of country differences. Generally, Italy evaluated bio-based products highest, whereas Slovenia showed the lowest evaluations.[8] In addition, this study showed that personality traits played a role in the evaluation of bio-based products. The effect of

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[8] Regardless of country-specific effects, differences in scores between countries could also be due to cultural differences in response styles (Van Herk et al., 2004). Moreover, countries differ in the extent to which their conmsumers are familiar with the term bio-based and/or may have confused the word with other meanings, like organic. This could also play a role in the evaluation of bio-based products. For example, on the one hand Slovenia has highest scores on familiarity with bio-based (see Table 5 and Table 4), but on the other hand, they have the lowest evaluations of the product examples used in this study. This raises the question whether they could have misinterpreted the word bio-based? Further research should investigate this issue.

introducing bio-based materials is more pronounced for respondents exhibiting higher levels of subjective knowledge, higher levels of domain-specific innovativeness, higher levels of health orientation and higher personal norms (i.e., those people that feel a higher moral obligation to protect the environment). These different personality traits may offer the basis for interesting consumers segments that could be used as targets for specific marketing strategies for bio-based products.

7.2. Discussion of findings on labels and information systems

How should bio-based products be communicated? What aspects are most important in communication and which communication sources are trusted most?

To answer these questions, we asked respondents to indicate what kind of specific information they would like to receive about bio-based products and to assess the trustworthiness of a number of different communication sources. The results of this study reveal that there is only a small body of consumers indicating they would prefer to see no information at all on bio-based products (less than 5%). All other consumers (across all countries) prefer to receive information on recyclability and biodegradability. Thus they state that they would like to receive information on how bio-based products are decomposed or recycled. In addition, the results show some differences between countries. Consumers from Italy, Czech republic and Slovenia also prefer to see health information. This can be explained by the fact that consumers from these countries associate bio-based products more with health impact.

Although there were small differences across countries, the trustworthiness of information sources shows a comparable ranking across countries. Information from consumer organisations was perceived to be most reliable across countries. For all countries, NGOs (especially in Denmark, Germany and Italy) and independent certifying organisations (especially in the Netherlands, Czech Republic and Slovenia) were also highly trustworthy. In contrast, television programs, newspapers, government and manufacturers were less trustworthy. These results suggest that cooperations with NGOs, consumer organisations or independent certifying organisations as information sources about bio-based, are most fruitful. Furthermore, Denmark, Germany, and the Netherlands have more trust in government as compared to manufacturers or suppliers of bio-based products, whereas Italy, Czech Republic and Slovenia have more trust in manufacturers of bio-based products than in the government. In Czech Republic and Slovenia the government is even perceived as less trustworthy information source. These country differences should be taken into account when companies launch bio-based products in different countries. In each country a careful selection of trustful information sources should be made.

What is the added value of labelling bio-based products with a logo or label?

To test the added value of labelling, we presented a question to the respondents in which they have to choose for different options of bio-based paint, with or without labels. The

results revealed that the option with Biodegradable logo is most often selected for a range of different product benefits (e.g., expensiveness, quality, attractiveness). The bio-based paint with the European Ecolabel logo is the second preferred option for all product benefits. The paint options with the labels showed also the highest buying preference among consumers (across all countries). Strikingly, bio-based paint without labels did not score better than no bio-based paint. This finding suggests that bio-based paint does not have any added value relative to no bio-based paint when there are no labels on the product. A logical conclusion then would be that companies using bio-based materials in their products should include a label on their products anyhow in order to differentiate their offerings in the market.

With regard to the European Ecolabel logo, we specifically asked respondents how familiar they are with the label and how they would evaluate this label. Results show that there are country-differences: Italian respondents are more positive towards the label and they more often inidcate that the Ecolabel is a well-known label. This may be due to the fact that the number of products with the Ecolabel in Italy clearly outnumbers the other European countries. For example, in countries like Germany and Denmark strong national labels are used. Notice that the Ecolabel logo was changed in 2010 (into the current flower logo), which also may have affected people's knowledge and familiarity.

Examination of the role of different personality traits showed that especially feeling a higher moral obligation to protect the environment (i.e, personal norm) plays a role in choosing bio-based products with labels. Interestingly, subjective knowledge seems to have an adverse effect: respondents with a higher subjective knowledge are more likely to select bio-based paint without a label as compared to the paint with Biodegradable logo. Again, these findings indicate that targeting different consumer segments with specific marketing strategies for bio-based products may pay off.

7.3. Limitations and directions for future research

The current study has some limitations. First, this study included six European countries. The advantage of including multiple countries is that the results are applicable to multiple countries. However, countries were selected based on their frontrunner status in the field of environmentally-friendly products and biotech products. As such, this might have given the results reported in this report a positive bias, especially when it comes to awareness of/ familiarity with bio-based products. Future research could seek to further generalize the findings from this study by taking other countries into account, especially those countries that are relatively lagging behind with regard to the market for environmentally-friendly products and biotech products. In addition, future research might dig deeper into country-specific differences, for example, by investigating culture-related factors. Specifically, Hofstede and his colleagues' work on national culture is highly relevant for a cross-culture study (Hofstede 1994). It would be highly worthwhile to examine how cultural differences on various dimensions, such as individualism vs. collectivism,

masculinity vs. femininity, and long-term vs. short-term orientation, will interplay with consumers' responses to bio-based products.

Second, we used an online consumer panel to recruit respondents. Subsequently, self-selection biases in agreeing to participate in a panel may be present. Moreover, the survey was conducted online. As a consequence, there may be some bias in internet access. Although internet penetration is generally high within Europe, there are some differences between the countries that were included in this research. For example, in

Italy only 57% of the population has an Internet connection at home at the time of the reported survey. Future research might also use different recruitment strategies, such as telephone surveys to get a broader sample.

A third limitation of this study is that, although the results should be interpreted with care and this study does not provide a decisive answer, there are at least strong indications that a relatively large amount of respondents seemed to have incorrect associations with bio-based. Their answers to a number of relevant questions suggest that they might have confused bio-based with more well-known terms like organic. Although on the one hand this seems to be a limitation of the study in the sense that probably a lot of respondents misinterpreted bio-based, thisfinding also shows how bio-based is perceived by consumers. Additionally, this insightprovides useful recommendations for further research. For example, future research could further disentangle the misconceptions that consumers have with regard to bio-based and dig into different associations across different groups of consumers as well as across the different countries in Europe. Moreover, future consumer research could further investigate whether bio-based is the right term to market these products, or whether other terms like plant-based or plant-made better cover the topic, and most important result in strait forward correct associatios by consumers.

The current study is among the first studies to explore consumer reactions towards bio-based products. The results therefore provide many interesting first insights, though also results in questions and future reserach lines. For example future research is necessary to further explore what the consequences of ambivalence are. We do not know whether ambivalence occurs due to a lack or an overload of information, and whether providing additional information is a strategy to resolve these mixed feelings. Or whether other mechanisms are necessary to reduce ambivalence, for example increasing trust. Future research should further elucidate determinants of ambivalence. Another example refers to the use of intentions as a dependent measure, future research might explore whether the current findings also hold for real behaviour (e.g., purchases of bio-based products).

7.4. Recommendations

As an overall conclusion, especially for policy makers, this research offers two routes to communicate bio-based products. The first route is probably the best route to achieve

familiarity and appreciation by consumers, but may also be the most complicated and long-lasting route: explaining completely what bio-based entails. This research shows that there is still a lot of confusion with regard to this term, and that it may be confused with concepts like organic. Explaining the concept, preferably on the basis of daily products of consumers or everyday examples, could solve this problem. For example, the ban on plastic shopping bags in Italy is a good vehicle to start the discussion about bio-based products. In explaining the concept, the disclosure of both risk and benefit information is important to allow consumers to make a fair consideration themselves (Jacobs, van de Poel & Osseweijer, 2010). The provision of benefit information, without communication about established or potential risks, may undermine public trust in those responsible for communication, as consumers then may infer that the communicator has

a vested interest in promoting a particular issue (McKee & Coker, 2009). There is one disadvantage related to this. Full disclosure of information is not a successfull strategy per se. Fischer et al. (2012) found that, following information provision, many of the individuals did not form a more positive attitude, but instead showed an increased ambivalence. The current findings show that ambivalence is also an important factor in explaining consumer intentions towards bio-based products. This finding indates that providing more information does not always result in a more positive attitude, it is important to find ways to deal with ambivalence.

The second route is offering bio-based as a precondition (preferable with a logo or label on the package of the product) without paying a lot of attention to explaining what the concept entails. This is a more risky route since (1) there is a risk that people form their own perceptions of what bio-based products are that are not conform to the truth, and (2) there is a risk that a company makes an (implicit) claim that they could not guarantee. In that case, companies risk to be convicted of 'greenwashing', where consumers are misled regarding the environmental practices of a company.

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Appendix A: Demographics

	Denmark (N=1012)	Germany (N=1135)	Italy (N=1060)	The Netherlands (N=1016)	Czech Republic (N=1008)	Slovenia (N=1011)	Total (N=6241)
Gender							
male	48.3	50.0	53.1	54.2	45.3	43.8	49.2
female	51.7	50.0	46.9	45.8	54.7	56.2	50.8
Age							
18-24	9.2	4.4	8.4	4.3	6.8	31.0	10.5
25-49	33.2	34.2	50.2	21.6	26.7	24.6	31.9
50-64	41.0	52.6	35.8	47.9	53.1	42.0	45.5
65 and plus	16.6	8.8	5.6	26.2	13.4	2.4	12.0
Household income							
Less than to €4.199 per year	3.1	4.8	7.4	3.5	8.8	11.7	6.2
€4.200 to €10.799 per year	6.1	9.2	10.8	5.7	22.9	28.6	12.9
€510.800 to €23.399 per year	12.2	23.4	31.9	24.2	29.8	41.8	25.9
€23.400 to €;43.199 per year	24.8	33.7	26.9	33.0	9.6	15.6	23.7
€43.200 or more per year	31.6	14.9	7.6	12.4	2.5	2.3	11.9
Don't know / Would rather not say	22.2	14.0	15.4	21.2	26.4	18.1	19.4
Family situation							
Married/ living together with children who are still at home	22.3	22.0	38.4	21.2	26.5	31.2	26.9
Married/ living together with children but not living at home	28.3	23.2	15.7	32.3	15.7	8.2	20.6
Married/ living together without children	13.2	17.5	8.3	16.2	20.4	13.2	14.8
Single with children who are still at home	5.1	6.6	5.2	4.0	5.2	5.2	5.0
Single together with children but not living at home	11.5	6.3	12.5	7.8	4.9	2.9	6.4
Single without children	15.3	19.8	16.1	15.0	10.0	12.0	14.2
Living together with my parents	3.1	2.4	3.7	2.7	4.7	19.7	8.0
Would rather not say	1.8	2.4	1.9	1.3	6.8	6.8	3.5
Other. please specify: ...	1.6	2.0	3.8	1.6	9.8	6.1	4.1

Appendix B: Items of the questionnaire

[Unless otherwise indicated, questions have Likert-type answer scales with end-points: 1= 'Totally disagree' to 7= 'Totally agree']

	I. GENERAL PERCEPTIONS OF BIO-BASED PRODUCTS
Open associations	- What positive associations do you have related to bio-based products? Please give up to 3 words. - What negative associations do you have related to bio-based products? Please give up to 3 words. - What products come to your mind when you think about bio-based products? Please give up to 3 words.
Familiarity	- Have you heard of bio-based products? ☐ Yes, and I know exactly what they are ☐ Yes, I have heard of it ☐ No, I have never heard of it
Aided associations Partly adapted from Food Choice Questionnaire, Steptoe et al. (1995)	Given your associations with bio-based products, for each of the following aspects please indicate how you would evaluate bio-based products on a scale from negative to positive: - Health - Appearance - Sustainable - Environment - Energy use - Recyclable - Naturalness - Innovative - High tech - Waste - Animal welfare - Technological - Safety - Price - Traded in a fair way [NB. Answer scales with end points ranging from 1= Very negative to 7= Very positive and 98=Don't know]
Awareness Adapted from brand awareness scale of Yoo et al. (2000)	- I can recognize bio-based products among other competing products. - I am aware of bio-based products. - Some characteristics of bio-based products come to my mind quickly. - I have difficulty in imagining bio-based products in my mind. (r)

Cronbach's alpha = .81

II. EVALUATION SPECIFIC BIOBASED PRODUCTS
[experimental design, based on product stimuli]

Risk perceptions Frewer et al. (1996)	- The risks associated with this product to me personally are - The risks associated with this product to the average person are - The risks associated with this product to the environment are - The risks associated with this product to future generations are *[Rated on 7-point scales with endpoints labeled from 1 "very low" to 7 "very high."; Cronbach's alpha = .91]*
Benefit perceptions Frewer et al. (1996)	- The benefits associated with this product to me personally are - The benefits associated with this product to the average person are - The benefits associated with this product to the environment are - The benefits associated with this product to future generations are *[Rated on 7-point scales with endpoints labeled from 1 "very low" to 7 "very high."; Cronbach's alpha = .94]*
Social norm Based on Ajzen (1991)	- I believe my friends want me to buy this product - I believe my family want me to buy this product - I believe my colleagues want me to buy this product *Cronbach's alpha = .95*
Perceived behavioral control Based on Ajzen (1991)	- I have the feeling that I can buy this product. - If I wanted to, I could buy this product the next week. *Cronbach's alpha = .66*
Positive emotions Based on	Knowing that you were buying/ using this product would make you feel: *Joy (Richins, 1997)*

Richins (1997), Tracy & Robins (2007), Kugler & Jones (1992)	- Happy - Pleased - Joyful *Pride (Tracy & Robins, 2007)* - Proud - Satisfied - Worthwile *Excited (Richins, 1997)* - Excited - Thrilled - Enthusiastic *Cronbach's alpha = .97*
Negative emotions Based on Richins (1997), Tracy & Robins (2007), Kugler & Jones (1992)	Knowing that you were buying/ using this product would make you feel: *Guilt (Kugler & Jones, 1992)* - Guilty - Remorseful - Burdened *Anger (Richins, 1997)* - Frustrated - Angry - Irritated *Worry (Richins, 1997)* - Nervous - Worried - Tense *Sadness (Richins, 1997)* - Depressed - Sad - Miserable *Cronbach's alpha = .98*
Ambivalence Priester & Petty (1996)	When you were buying/ using this product ... - I feel no conflict at all ... I feel maximum conflict - I feel no uneasiness at all ... I feel maximum uneasiness - I have no mixed feelings ... I have strong mixed feelings *[NB. Semantic scales ranging from 1 to 7; Cronbach's alpha = .94]*
Behavior purchase intention	- I would use this product. - I would buy this product. - I intend to buy this product.

Cronbach's alpha = .97

III. LABELLING AND COMMUNICATION	
Desired information	What kind of specific information do you think should be communicated about bio-based products? Please select a maximum of 3 options from the list below - The percentage of the bio-based (plant-based) content - CO_2 footprint of the product - Environmental impacts of the product's life-cycle - Environmental impact of the raw material production of my product - Health impact (benefits) - Safety impact (benefits) - Product functionalities - Compostability (i.e., the extent to which a product can be composted in my garden or can be industrially compostable) - Energy saving - Recyclability (i.e., product can be recycled) - Biodegradability (products that can be decomposed back into natural elements) - Social impact of production - No communication at all - Other, please specify: ......
Label preference	Please compare these four products according the following characteristics.... - The most expensive - The highest quality - The most attractive - The most environmentally friendly - The safest - The healthiest - The one I would like to buy Three of the above products show bio-based paint. We are interested to know if it is clear to you what is meant with bio-based for this product. I have no idea ... It is fully clear to me
Evaluation EU Ecolabel	- The EU Ecolabel is a well-known label for consumer products. - The EU Ecolabel is a trustworthy label for consumer products. - The EU Ecolabel informs me well about the environmental aspects of the products. - The EU Ecolabel informs me well about the quality aspects of the products.
Trust in information sources	When getting information about bio-based products, how reliable or unreliable would you find the following sources? - Family and friends - Television programs - Newspapers and magazines - Internet - Government/ governmental agency - NGOs (e.g., WWF, Greenpeace) - Consumer organisations (e.g., Consumers' association) - Manufacturer/ supplier of bio-based products - Independent certifying organization - University [Rated on 7-point scales with endpoints labeled from 1 "very unreliable" to 7 "very reliable"]

IV. PERSONAL CHARACTERISTICS & VALUES

Domain-specific innovativeness Goldsmith & Hofacker (1991)	- If I heard that biobased products were available through a local store, I would be interested enough to buy it. - I would consider buying biobased products, even if I hadn't heard of it yet. - I know more about biobased products than other people do. *Cronbach's alpha = .79*
Subjective knowledge Pieniak et al. (2007)	- I consider that I know more about biobased products than the average person - I think that I know more about biobased products than my friends - I have a lot of knowledge about biobased products - I have a lot of knowledge about how to evaluate biobased products *Cronbach's alpha = .94*
Health orientation Dutta-Bergman (2004)	- I do everything I can to stay healthy. - Living life in best possible health is very important to me. - I actively try to prevent disease and illness. - Eating right, exercising, and taking preventive measures will keep me healthy for life. - My health depends on how well I take care of myself. *Cronbach's alpha = .88*
Safety orientation Based on De Jonge et al. (2007)	- I worry about the safety of products. - I feel uncomfortable regarding the safety of products. - I express my worries about safety of food to others. - I try to inform myself as much as possible about the safety of food. *Cronbach's alpha = .87*
Personal norm Adapted from Gärling et al. (2003)	- I feel a moral obligation to protect the environment. - I feel that I should protect the environment. - I feel it is important that people in general protect the environment. - Because of my own values/principles, I feel an obligation to behave in an environmentally-friendly way. *Cronbach's alpha = .94*
Socio-	- Age

demographics	-	Gender
	-	Education
	-	Income
	-	Household status
	-	Household decision making
	-	Membership NGOs

Appendix C: Results of experiment on explanatory variables of model

Explanatory variables (benefit perception, risk perception, social norms, perceived behavioural control)

The main effects for bio-based level reveal that all explanatory variables differ across the 3 percentages of bio-based (i.e., 0%, 30% and 100%; see Table 12). Furthermore, except for social norms, all variables differ significantly across the 3 products and the 6 countries. Significant interactions between bio-based level and product are reported for all variables and significant interactions between bio-based level and country are reported for all variables. Also significant interactions between product and country are reported for all variables. Finally, there is a significant three-way interaction between bio-based level, product and country for benefit perception.

An inspection of the means of the bio-based levels demonstrates that the full (100%) bio-based product shows the highest scores on benefit perceptions, social norm, and perceived behavioural control and the lowest score on risk perceptions, followed by the partly (30%) bio-based option. The non bio-based option shows the lowest scores, although still around the midpoint of the scale. Except for perceived behavioural control, Bonferroni post-hoc tests showed that all means of the 3 bio-based levels are significantly different from each other for all explanatory variables ($p < .05$).

When looking at the means of the different products for the different explanatory variables, we see that the Garnier shampoo is rated highest in terms of benefit perceptions and perceived behavioural control and lowest for risk perceptions. Coca-Cola received a significantly higher score on risk perception and perceived behavioural control than the store brand coke, but both products do not significantly differ in terms of benefit perception. The three products do not differ in their scores on social norm.

Finally, when looking at the means of the different countries for the different explanatory variables, we see that generally Italy has the highest scores (except for risk perceptions) and Slovenia has the lowest scores (except for risk perceptions and perceived behavioural control). Strikingly, Denmark has the highest score on risk perceptions.

Ambivalence

The main effects for bio-based level reveal that ambivalence differs across the 3 bio-based levels (see Table 12). Furthermore, ambivalence differs significantly across the 3 products and the 6 countries. Also, a significant interaction between bio-based level and product and a significant interaction between product and country are reported. Finally, there is no significant three-way interaction between bio-based level, product and country.

An inspection of the means of the bio-based levels and Bonferroni post-hoc tests demonstrate that the full (100%) bio-based product does not differ significantly from the partly (30%) bio-based product. Instead, both bio-based conditions are significantly different as compared to the non bio-based option ($p < .05$).

When looking at the means of the different products, we see that the Garnier shampoo is rated lowest in terms of ambivalence. Coca-Cola and the store brand coke do not significantly differ in terms of ambivalence.

Finally, when looking at the means of the different countries, we see that Denmark and Slovenia have significantly higher scores on ambivalence than the other countries ($p < .05$).

Table 12: Estimated marginal means for explanatory variables for all countries

		Risk perception	*Benefit perception*	*Social norm*	*Perceived behavioural control*	*Ambivalence*
Bio-based level						
Non bio-based (N=1875)		4.07[a]	3.44[a]	2.75[a]	4.70[a]	3.34[a]
Partly bio-based (N=1868)		3.65[b]	3.96[b]	3.21[b]	4.62[a]	2.94[b]
Full bio-based (N=1871)		3.35[c]	4.31[c]	3.52[c]	4.77[b]	2.84[b]
Product						
Coca-Cola bottle (N=1871)		3.95[a]	3.78[a]	3.18[a]	4.67[a]	3.18[a]
Store brand coke bottle (N=1870)		3.84[b]	3.82[a]	3.14[a]	4.49[b]	3.22[a]
Garnier shampoo (N=1873)		3.29[c]	4.12[b]	3.17[a]	4.94[c]	2.72[b]
Country						
Denmark (N=915)		4.34[a]	4.18[a]	3.11[a]	4.35[a]	3.30[a]
Germany (N=1030)		3.44[b]	3.92[b]	3.34[b]	4.90[b]	2.90[b]
Italy (N=934)		3.50[b]	4.37[a]	3.92[c]	5.06[b]	2.97[b]
The Netherlands (N=916)		3.43[b]	3.84[b]	2.84[d]	4.66[c]	2.91[b]
Czech Republic (N=908)		3.53[b]	3.77[b]	3.25[a,b]	4.32[a]	2.84[b]
Slovenia (N=911)		3.93[c]	3.34[c]	2.51[e]	4.91[b]	3.33[a]
Main effect Bio-based level	F	119.14***	156.54***	94.40***	103.81***	3.38*
	(df1,df2)	(2, 5560)	(2, 5560)	(2, 5560)	(2, 5560)	(2, 5560)
	Partial η^2	.041	.053	.033	.036	.001
Main effect Product	F	113.10***	28.51***	.21	28.06***	33.47***
	(df1,df2)	(2, 5560)	(2, 5560)	(2, 5560)	(2, 5560)	(2, 5560)
	Partial η^2	.039	.010	.000	.010	.012
Main effect Country	F	60.89***	50.84***	72.96***	71.81***	30.38***
	(df1,df2)	(5, 5560)	(5, 5560)	(5, 5560)	(5, 5560)	(5, 5560)
	Partial η^2	.052	.044	.062	.061	.027
Main effects Bio-based level *Product	F	4.45**	6.55***	3.42**	5.96***	4.75**
	(df1,df2)	(4, 5560)	(4, 5560)	(4, 5560)	(4, 5560)	(4, 5560)
	Partial η^2	.003	.005	.002	.004	003
Main effects Bio-based level *Country	F	19.69***	30.87***	2.03*	1.80	5.24***
	(df1,df2)	(10, 5560)	(10, 5560)	(10, 5560)	(10, 5560)	(10, 5560)
	Partial η^2	.034	.053	.004	.003	.009
Main effects Product*Country	F	19.49***	7.06***	7.48***	11.92***	4.52***
	(df1,df2)	(10, 5560)	(10, 5560)	(10, 5560)	(10, 5560)	(10, 5560)
	Partial η^2	.034	.013	.013	.021	.008
Main effects Bio-based level *Product*Country	F	1.47	2.56***	1.05	.74	1.57
	(df1,df2)	(20, 5560)	(20, 5560)	(20, 5560)	(20, 5560)	(20, 5560)
	Partial η^2	.005	.009	.004	.003	.006

Notes: Answer scales ranged from 1 to 7; Means with a different superscript (a, b, c) indicate a significant difference ($p < .05$) (means are compared two at a time); *** $p < .001$; ** $p < .01$; * $p < .05$.

Given the objective of the experiment, it is good to have a closer look at the interaction effects between bio-based level and products. Figure 10 below showed the patterns for the different products for the different bio-based levels. The most striking result is that the positive effect of bio-based looks more pronounced for the cola bottles as compared to the Garnier shampoo. When comparing Coca-Cola and the store brand cola, it looks like the positive effect of bio-based is somewhat more pronounced for store brand cola, especially between the no bio-based and the 30% bio-based conditions. In addition, it seems that the negative effect of bio-based on ambivalence is more pronounced for the cola bottles as compared to the Garnier shampoo. When comparing Coca-Cola and the store brand cola, it looks like the negative effect of bio-based on ambivalence is somewhat more pronounced for store brand cola, especially between the non bio-based and the 30% bio-based conditions.

Figure 10: Interaction effects between bio-based levels and products on explanatory variables
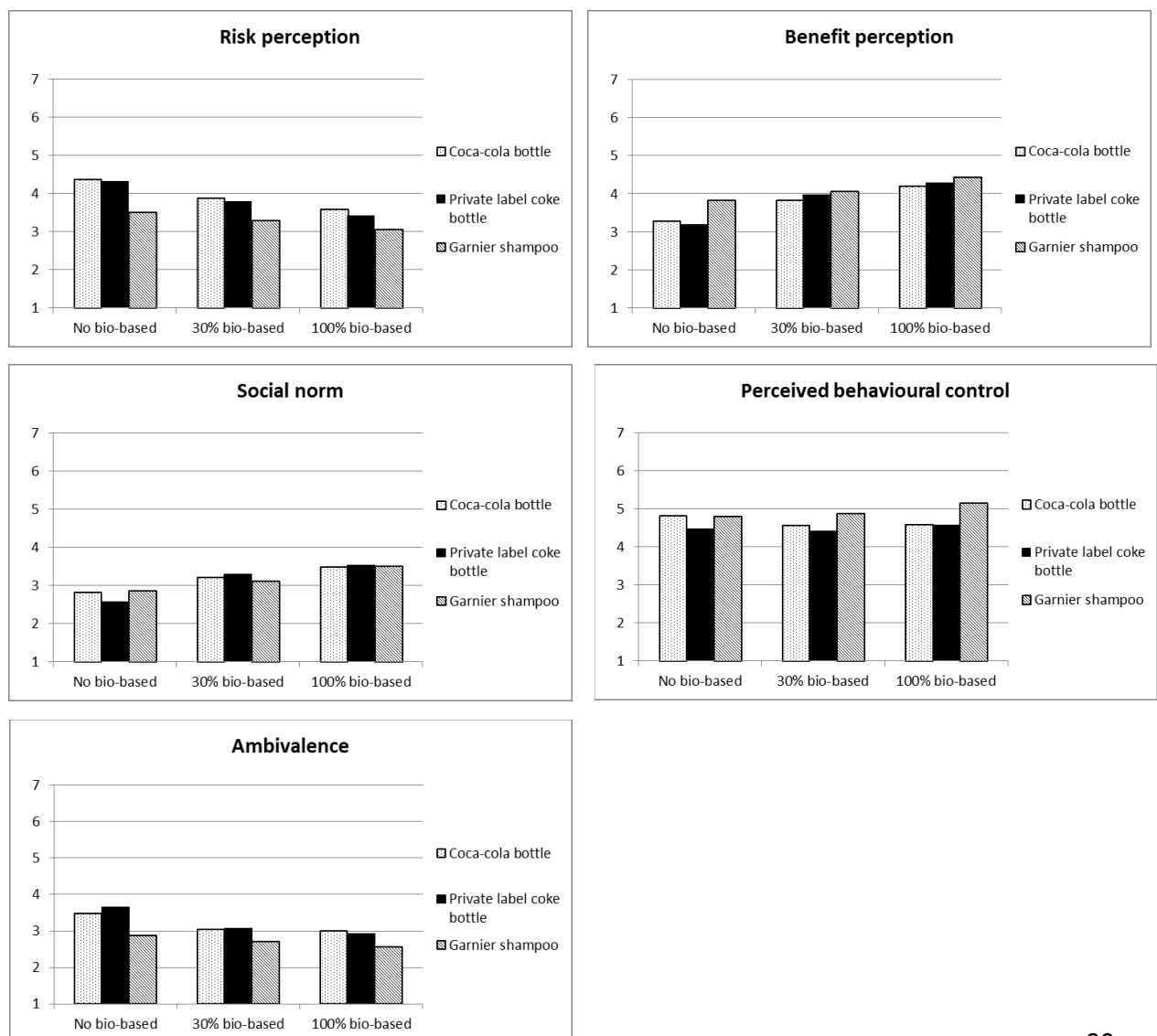
Role of personal characteristics

In addition to the interactions between the different bio-based levels with different percentages of bio-based materials and the different products/ brands, we also checked whether personal characteristics play a role in the evaluation of the different products. Therefore, we distinguished between respondents with low and high scores on the various personal characteristic variables based on the sample median.

Table 13 displays the interaction effects between level of bio-based (no bio-based/ 30% bio-based/ 100% bio-based) and personal characteristics (divided into the degree to which respondent possesses a specific characteristic: high/ low). Significant interaction effects between bio-based level and personal characteristics are found for all variables.

- The effect of bio-based is more pronounced for respondents exhibiting higher levels of subjective knowledge. Especially the difference in scores between the no bio-based and the 30% bio-based condition is higher for respondents who possess higher levels of subjective knowledge;

- The effect of bio-based is also more pronounced for respondents exhibiting higher levels of domain-specific innovativeness. Again, the difference in scores between the no bio-based and the 30% bio-based condition is higher for respondents who possess higher levels of domain-specific innovativeness;

- The effect of bio-based is also more pronounced for respondents exhibiting higher levels of health orientation. Again, the difference in scores between the no bio-based and the 30% bio-based condition is higher for respondents who possess higher levels of health orientation;

- The effect of bio-based is also more pronounced for respondents that care more about the environment (i.e., personal norm). For the positively formulated variables (i.e., benefit perception, social norm, and perceived behavioural control), especially the increase in scores between the 30% bio-based and the 100% bio-based condition is higher for respondents with high personal norms, whereas for the negatively formulated variables (i.e., risk perception and ambivalence), the decline in scores between the no bio-based and the 30% bio-based condition is higher for respondents with high personal norm.

Open-BIO

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Table 13: Moderating effects: is the effect of the different percentages of bio-based different for different personalities?

	Risk perception	Benefit perception	Social norm	Perceived behavioural control	Ambi-valence
Subjective knowledge	*n.s.*	+	+	+	-
Domain-specific innovativeness	-	+	+	+	-
Personal orientation: health orientation[9]	-	+	+	+	-
Personal Norms	-	+	+	+	-

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[9] Notice that next to health orientation we also incorporated safety orientation as a personal characteristic in this study. We found similar results as for health orientation.

Appendix D: Differences across groups of consumers

Data preparation and analyses

This report shows in Section 4.1 that consumers differ in their associations with bio-based products. The open associations show that a large amount of consumers has incorrect associations with bio-based. They associated bio-based with organic and/or food products. In this paragraph we aim to explore whether respondents with correct versus incorrect associations differ in self-reported awareness, guided associations and which information they would like to receive. We emphasize that this is an explorative paragraph. The open question was not included in the study to divide respondents in correct versus incorrect answers. If this was the main goal of this project, we for example would have added objective knowledge questions. The open question merely provides an indication of correct versus incorrect associations, though some unclarity remains. For example, we do not know whether consumers who associate bio-based with clothes or detergents do this because they really know what bio-based is or because they think of organic products. The results in this paragraph should therefore be interpreted carefully. The results are exploratory and provide indications for differences across these two groups.

The most often recalled answers to the question "What products come to your mind when you think about bio-based products?" were coded as correct (cosmetics, cleaners, detergents, fuel, oil, clothing, and building) and incorrect (vegetables, fruit, organic, food, meat, eggs, and milk). Then, ANOVAs were performed to explore whether these groups differ on awareness, guided associations and whioch information they would like to receive.

Results

The results show that of the coded answers (*N*=2861), 79.5% of the respondents provided incorrect associations and 20.5% provided correct associations with specific products. Note that this finding does not provide insight in the percentage of total respondents with correct versus incorrect answers since we took a sample with the answers that were provided most often.

Familiarity with bio-based products

Chi-square difference tests reveal differences across the two groups (incorrect versus correct associations with bio-based products). The results show that in consumers with incorrect associations are more likely to indicate to exactly know what bio-based products are, whereas respondents who recall correct associations indicate more often to have heard of these products or do not know what they are (see Table 14). This might seem counterintuitive at first. Though these results might imply that respondents with incorrect associations falsely associate bio-based with organic products or other type of products that are more well known.

Table 14: Familiarity with bio-based products in percentages for respondents with incorrect and correct associations with the term bio-based

	incorrect	correct	total
	N=2275	N=586	N=2861
Yes, I know exactly what they are	30.0%	17.1%	27.4%
Yes. I have heard of it	53.5%	61.6%	55.1%
No. I have never heard of it	16.5%	21.3%	17.5%

Aided associations with bio-based products.

Table 15 shows the means for a range of provided possible associations with bio-based products. The table only shows the aided associations that differ significantly across the two groups. There were no significant differences for health, appearance, naturalness, animal welfare, safety, and traded in a fair way.

The table also shows the mean scores of the total sample to provide an indication how these two subsamples (incorrect versus correct associations) relate to the total sample. The results show that respondents with a correct association associate the term bio-based more often with sustainable, environment, energy use, recyclable, innovative, high tech, technological, and price.

Table 15: Guided associations with bio-based products in percentages for respondents with incorrect and correct associations with the term bio-based

	incorrect	correct	total sample
	N=2275	N=586	N=6228
Sustainable	5.40	5.74	5.48
Environment	6.00	6.15	5.95
Energy use	5.17	5.42	5.25
Recyclable	5.80	6.05	5.84
Innovative	5.22	5.67	5.38
High tech	4.83	5.23	5.01
Technological	4.80	5.28	4.98
Price	3.47	3.81	3.58

Information that should be communicated.

Respondents were asked to select a maximum of three items from a list of 14 possible communication contents. Table 16 shows the percentage of respondents that indicates to prefer the specific information. The table only shows the information messages that differ significantly across the two groups. There were no significant differences for Environmental impact. Safety impact, Product functionalities, Energy saving, Recyclability, Biodegradability, Social impact, or No communication.

The table also shows the mean scores of the total sample to provide an indication how these two subsamples (incorrect versus correct associations) relate to the total sample. The results show individuals with incorrect associations are more willing to receive information regarding health, whereas individuals with correct associations are more willing to receive information regarding the environment (CO_2 and composability).

Table 16: Information that should be communicated in percentages for respondents with incorrect and correct associations with the term bio-based

	incorrect	*correct*	*total*
	N=2275	N=586	N=1227
CO^2 footprint of the product	14.2	20.6	16.6
Health impact (benefits)	55.1	47.4	43.9
Compostability	14.9	21.7	18.8

Factors explaining consumer acceptance of bio-based products.

This project also included a range of factors to explain consumer intentions to buy bio-based products. Table 17 shows the means for the factors that differ significantly across the two groups. There were no significant differences for attitudes, social norms, negative emotions, positive emotions, perceived benefits, and intentions.

The results show that respondents with incorrect associations with bio-based have a higher score on awareness and perceived behavioural control and a lower score on ambivalence and perceived risks. This finding again might be counterintuitive at first but might indicate that individuals with incorrect answers might have confused bio-based with organic products.

Table 17: Factors explaining consumer acceptance of bio-based products in percentages for respondents with incorrect and correct associations with the term bio-based

	incorrect	*correct*
	N=2275	N=586
awareness	4.17	3.78
perceived behavioural control	4.87	4.68
ambivalence	2.97	3.16
perceived risks	3.62	3.84