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Indicators of Consumers' Preferences for Bio-Based Apparel: A German Case Study with a Functional Rain Jacket Made of Bioplastic

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Abstract: Plastic pollution is an increasing global problem, however, replacing fossil resources with bioplastics made from renewable resources could be part of the solution. Currently, no research analyzing the influencing factors for consumers' preferences for functional apparel made of bioplastic material could be found. To close this gap in research, we conducted this study with a sample of 1673 participants that were representative of the German population aged 16 years and above. We conducted a choice based conjoint analysis for a bio-based rain jacket and measured psychographic indicators that were used as covariates in the statistical estimation of participants' preferences for the rain jacket. Our results show the high level of importance of prior product experience, Green Consumer Values and attitude towards bioplastic for selecting bio-based apparel, and thus give first insights related to the influence of psychographic characteristics of consumers when selecting bio-based apparel.

Keywords: bio-based apparel; choice based conjoint analysis; psychographic indicators; bioplastic; preferences; covariates

1. Introduction

Plastics have become an increasing global waste problem over the last decades [1–4]. Plastic waste and micro-plastics can be found in almost every ecosystem in the world. Awareness of plastic pollution in the air, on land and in the oceans has raised the need to protect these ecosystems and find cleaner solutions or even substitutes for conventional plastics. One possible strategy is changing the raw materials in plastic products by replacing crude oil with biomass. Therefore, bioplastics are considered to be part of the answer to this challenge and a substitute for conventional plastics.

Bioplastics are made of renewable resources and contain carbon dioxide sequestered by plants. Bioplastics have been part of industrial life for several decades. There is strong demand for renewable solutions with respect to plastic pollution and the substitution of fossil resources use, meaning that bioplastics are gaining importance. However, the definition of bioplastics is not easy to understand for consumers. Bioplastics can be manufactured partly or completely from biogenic raw materials from various types of plants. The raw material compounds can be, for example, bioethanol (sugar cane), oil (castor bean or canola oil), starch (potatoes) or cellulose (leaf of plants). The different types of bioplastic are not necessarily biodegradable. Additionally, current "drop-in" bioplastics are chemically identical to their petrochemical equivalents, with the only difference being that the source of the carbon is not fossil fuel. There are also "novel" bioplastics (like e.g., polylactic acid, polyhydroxyalkanoates or polyethylene furanoate), which differ in chemical structure and properties from conventional plastic [5–8].

The differentiation between conventional plastic products and bioplastic products is not obvious for consumers, as there are usually no visible attributes that can be used to distinguish the plastics from one another, especially in situations where consumers make a choice. In addition, public knowledge about bioplastics is very diffuse and limited in Germany [9]. Considering these issues and the acuteness of the pollution problems, it is important to understand consumers' choices with respect to bioplastic products.

Apparel is a product that is used daily. Modern apparel often uses plastic fibers, especially for functional clothes. Hence, fibers stemming from bio-based plastics with lower carbon dioxide emissions could be used to substitute large amounts of fibers made from crude oil [10–12]. This leads to the question as to whether consumers intend to purchase bio-based functional apparel and what the possible drivers of consumer choice for bio-based functional apparel are.

So far, the drivers and factors influencing consumer choice for bio-based products are not well known and only a few studies have been carried out in this field [13–19]. None of these studies analyzed consumer choices relating to bio-based apparel. Another path of research has examined the relationship between the choice of green or organic apparel and psychographic variables [20–26]. However, no study thus far was found to combine these two fields of research. To partially close this gap, we place special emphasis on the choices made by consumers with respect to a functional rain jacket made of bioplastic using a choice-based conjoint experiment (CBC) in this study. Furthermore, we analyze the influence of psychographic indicators (covariates), which we assume affect the preference for bio-based apparel. Based on these covariates, we describe the relationship between the selected psychographic scales and the preferences measured through the CBC. Thus, this study gives first insights related to the influence of psychographic characteristics of consumers when selecting bio-based apparels. Relevant influencing factors were identified through a literature review, which especially focused on previous studies relating to green apparel, bio-based products and green products in general. Our main research questions are:

Which attributes of bio-based apparel are relevant for consumers' preferences?
Which covariates have an influence on certain attributes of bio-based apparel?
How strong are the influences of certain covariates on consumer choices?

The results of the literature review and the derived hypotheses are described in Section 2, followed by information on data collection and analysis in Section 3. In Section 4, we present the results of the covariate-estimation and discuss the influences of the covariates on the choices made by respondents relating to the attributes of the bio-based rain jacket. In addition, the limitations of the study and the implications for different stakeholder groups are discussed.

2. Literature Findings and Hypotheses

This study investigates psychographic and other factors that influence preferences for specific attributes of apparel made of bioplastic. Initially, we reviewed scientific literature to generate hypotheses that investigate the influence of psychographic and other variables on the attributes that are relevant choosing bio-based and green products. In this section, the investigated psychographic variables are defined, the reasoning for each variable is provided and the relationship to the attribute used in the CBC is shown. Finally, we postulate the hypotheses to be tested.

Product experience: Cowan and Kinley [27], Khare and Sadachar [28] and Nam et al. [29] show that prior purchases of green apparel is an indicator for future purchases. Lin [30] showed that consumers are interested in the fabric content label prior to the purchase of a garment and that this also relates to the past purchase of organic apparel. Therefore, we expect that prior consumption behavior is an indicator for the preference for rain jackets made of bioplastic. This also leads to the assumption that no prior product experience negatively affects the preference for a rain jackets made of bioplastic and that consumers would choose a conventional rain jacket.

Hypothesis 1 (H1). *No prior product experience with bio-based apparel decreases the probability of consumers' preferences for it.*

Green Consumer Values (GCV): Haws et al. [31] found evidence of a correlation between an environmental attitude (scale: GCV) and respondents' preferences for ecological products. Kurka [19], Scherer et al. [13] and Scherer et al. [15] revealed that consumers with stronger environmental attitudes or higher GCV tend to choose bio-based products. Thus, we assume that consumers with high GCV prefer a high percentage of bio-based material in the fabric that is used to make a functional jacket and vice versa.

Hypothesis 2a (H2a). *Higher GCV increase consumers' preferences for a high percentage of bioplastic in the fabric used to make bio-based apparel.*

Hypothesis 2b (H2b). *Lower GCV decrease consumers' preferences for a high percentage of bioplastic in the fabric used to make bio-based apparel.*

The intensively debated food versus fuel dilemma has been examined in various studies [32–34]. Consumers with higher GCV possibly perceive the use of agricultural resources for bioplastic as conflicting more with food security, whereas products made from forest wood can be perceived as conflicting less with food resources. Scherer et al. [13,15] found that the resources used to create the bio-based material used for a product is relevant for consumers' preferences for products such as this. We assume that the food versus fuel dilemma influences the choice of product when the resources the product is made of are taken into account. Thus, we expect that the crop used as a source of material is a factor that influences preference for bio-based rain jackets in consumers with high GCV.

Hypothesis 2c (H2c). *Higher GCV increase consumers' preferences for resources with a perceived low food versus fuel dilemma in the case of bio-based apparel.*

Ellis et al. [35], Chen and Chai [36] and Umberson [37] found that environmental attitudes are positively related to a high purchase intention towards green sportswear. Furthermore, Scherer et al. [13], Kainz [18] and Kurka [19] showed that respondents with high GCV are less sensitive to increased prices for bio-based products. Thus, we assume that higher GCV would decrease the importance of low prices with respect to bio-based apparel.

Hypothesis 2d (H2d). *Higher GCV decrease the relevance of low prices for bio-based apparel.*

Altruism: Altruism produces prosocial behavior. As defined by Batson and Powell [38], altruism is the motivation to increase another person's welfare and has been found to be a predictor for the preference for green products and green consumption by Stern et al. [39], Pfattheicher et al. [40], Teng et al. [41] or Hefner [42]. Based on these findings, we assume that a person's level of altruism is an indicator for the preference for green apparel and is expressed by reduced relevance of paying lower prices for bio-based products.

Hypothesis 3a (H3a). *Higher altruism decreases the relevance of low prices for bio-based apparel.*

Lusk et al. [43] found that individuals who are more altruistic are willing to pay more for environmentally certified pork. Grolleau et al. [44] also showed that altruism influences the preference for eco-labelled environmentally friendly products. Thus, we conclude that consumers with a higher level of altruism are more likely to prefer certified bio-based apparel.

Hypothesis 3b (H3b). *Higher altruism increases consumers' preferences for the certification of bio-based apparel.*

Attitude towards bioplastics: Hartmann and Apaolaza-Ibáñez [45] and Teng et al. [41] revealed that consumers' environmental attitudes have a positive influence on the preference for green products. Recent studies by Rumm [17], Kurka [19] and Scherer et al. [13] found a connection between environmental attitudes and preferences for bioplastic products. As bioplastics are expected to help solve environmental issues caused by conventional plastics, they can be considered environmentally advantageous. Thus, environmental attitudes and the attitude towards bioplastics seem to be strongly related. Hence, we expect that attitude towards bioplastics has a similar influence on preferences as environmental attitudes have on green products. Furthermore, environmental attitude is an indicator for the preference for bio-based apparel and a higher percentage of bioplastic in the fabric.

Hypothesis 4a (H4a). *Higher attitude towards bioplastics increases consumers' preferences for bio-based apparel.*

Hypothesis 4b (H4b). *Higher attitude towards bioplastics increases consumers' preferences for a high percentage of bioplastic in the fabric of bio-based apparel.*

As consumers can hardly distinguish bio-based plastic products from conventional plastic products, the recognition of bio-based products needs to be supported through visual aids, such as labelling or certification. Nam et al. [29] revealed that consumers' attitude have a positive influence on the intention to purchase green sportswear. D'Souza et al. [46] found that there is a relationship between consumers perceiving labels as relevant for the willingness to pay higher prices for green-labelled alternatives and argued that environmental attitude can be a relevant factor for perceiving eco-labels. We propose that attitude towards bioplastics as a type of environmental attitude influences preference for the labelling of bio-based apparel.

Hypothesis 4c (H4c). *Higher attitude towards bioplastics increases consumers' preferences for a certification of bio-based apparel.*

Trust: Trust as defined by Beierlein et al. [47] is an indicator of someone's ability to trust other persons' actions. According to Atkinson and Rosenthal [48], trust in green products is influenced by the source of an eco-label and the argument specificity of the product. Several previous studies measured green trust scales as predictors of green consumption [48–54]. Atkinson and Rosenthal [48] and Young et al. [49] argued a possible general influence of trust towards green products. Thus, we assume that trust is a possible factor influencing preferences for bio-based apparel generally as trust in claims can be understood as trust in agents' products. Especially eco-labels must be seen as an effort to gain consumers' trust [55,56]. Therefore, we claim that trust can be connected towards the trust into the certification of product labels of bio-based apparel.

Hypothesis 5a (H5a). *Higher trust increases consumers' preferences for a certification of bio-based apparel.*

For consumers to purchase products, they need to trust in the product and this is connected to familiarity with products and their origin, as found by Fandos Herrera and Flavián Blanco [57] and Jiménez and San Martín [58]. Consequently, we assume that lower levels of trust increase the preference for bio-based apparel with a biomass source that is produced nationally.

Hypothesis 5b (H5b). *Lower trust increases consumers' preferences for bio-based apparel made with biomass from sources that are produced nationally.*

Innovation-friendly: Consumers' innovativeness is also an important driver for the adoption of environmentally friendly product innovations, as found by Tellis et al. [59], Rahman et al. [60] and Jansson [61]. Recently, Osburg et al. [62] showed that choices for wood-plastic composites over conventional plastics correlated with the respondents' innovativeness. Furthermore, Scherer et al. [13]

revealed that ecologically sensitive respondents are more innovative. Thus, we assume that respondents that are more innovative (short scale of Tellis et al. [59] innovativeness-scale) prefer bio-based apparel with a higher percentage of bioplastic in the fabric.

Hypothesis 6 (H6). *Higher innovation-friendly increases consumers' preferences for a high percentage of bioplastic in the fabric of bio-based apparel.*

3. Data and Methods

Here, we describe how the data was collected and the theoretical background on the choice based conjoint analysis (CBC) and the covariates used in our model.

3.1. Data Collection

We collected data through an online access panel in June 2016. This was done through a subcontracted market research company, which recruited the respondents. The participants in the study received pre-determined incentives for completing the full survey. Web surveys are less costly and allow a fast data collection [63]. We aimed for a representative group of the German population aged 16 or above, with the sociodemographic characteristics being based on the German sample census from 2015 (="Mikrozensus") [64]. Quotas were set on gender, age, education and the number of inhabitants in the town of residence (Table 1). The questionnaire of the survey included—amongst other topics—a CBC experiment, items operationalizing the chosen psychographic variables, and sociodemographic information related to the respondents. Subsequent to the data collection, we cleaned the data to remove answers that were not feasible (straight-liners, Christmas-tree-behavior, conflicting answers, incorrectly answered test-questions, etc.), which left 1,673 responses for the statistical analysis. Data management and analysis was performed using Sawtooth 8 [65] and SPSS 23 [66]. The identical data set was used in the study by Klein et al. [67] that was targeted to other research questions.

Table 1. Sociodemographic data of the sample *.

Variable	Sample	Germany Population 16+ [64]
Age		
16–19 years	0.050	0.046
20–29 years	0.127	0.141
30–39 years	0.124	0.141
40–49 years	0.166	0.180
50–59 years	0.185	0.180
60+ years	0.348	0.312
Sex		
Female	0.519	0.513
Male	0.481	0.487
Education		
Not yet graduated	0.025	0.025
Secondary modern school without apprenticeship	0.071	0.079
Secondary modern school with apprenticeship	0.320	0.306
General certificate of secondary education	0.298	0.303
General qualification for university entrance	0.127	0.131
Academic studies	0.160	0.157

Note: * The same data was used in the study of Klein et al. [67] with an identical socio-demographic structure of the sample.

3.2. Methods

We conducted a CBC and used Hierarchical Bayes (HB) estimation to analyze the data. We included several covariates in the HB estimation, which we derived through factor analysis. In this section, we describe the approach and methods used.

3.2.1. Choice Based Conjoint Analysis

Choice-based conjoint analysis is a well-known and valid method to research preferences for innovations or existing products [68,69]. Even though the measured choices do not necessarily lead to purchase behavior, they provide insights into motivations for buying certain products, for example, the attributes that consumer consider important or willingness-to-pay. This enables research on the current state of consumers' demand or for marketing strategies to be developed. Choice measurements with a high number of respondents can help to reveal the predictors of decision making processes. A respondent's preference results from the chosen product concepts in the CBC. Therefore, a set of attributes with realistic and existing occurrences (levels) need to be set (Table 2). The product concepts are randomly constructed (random tasks) or explicitly selected (fixed tasks). The fixed tasks are part of the validation of the method. By choosing the illustrated product concepts, respondents value each attribute-level. Through the utility function, it is possible to translate the choices made into the consumers' perceived preferences, which can potentially be used to predict purchase decisions [69].

Table 2. Attributes and levels of the choice-based conjoint-analysis.

Attributes	Levels
Percentage of bioplastic in fabric	100% 50% 20%
Biogenic resource	Potatoes Chipped wood Sugar cane Corn
Origin of resource	South America European Union United States of America Asia
Product certificate	Free of pollutants Climate protection Fair production Without certificate
Price	349 € 239 € 109 € 69 €

3.2.2. Attributes, Levels and Product-Concepts

When conducting CBC-experiments, a set of attributes with different levels is needed for the product concepts. In our study, we considered attributes that either already exist or potentially play a role in the German market. We defined the attributes and levels based on expert interviews, a market analysis and a literature review (Table 2). We found the lowest attribute-levels for "percentage of bioplastic in fabric" (20%) in the market for rain jackets in 2016. The higher levels (50%, 100%) were set in order to simulate the effects of more ambitious targets. The biogenic resources shown in the CBC contain plants/byproducts that can be used to manufacture bioplastics for use in textiles. Sanad [70] found that the origin of the apparel is relevant for consumers. Furthermore, Scherer et al. [13,15] showed that the origin of the plant material is important for consumers' preferences for bioplastic products. Thus, the attribute "origin of resource" was included in the choice set, with its levels representing the globalized economy and considering important regions in which raw material plants for apparel could be produced. According to Chekima et al. [71] and Borin et al. [72] eco-labels or certificates are of value for consumers to build trustworthy products, to communicate certain properties of a product and to promote the purchase of green products. Hence, we included the attribute "product certificate" in our CBC design and defined three certificate types frequently found on the German

market. The prices we chose for the CBC cover a wide range (69 € to 349 €), but this depicts a realistic view of the German market for functional rain jackets. Additionally, we included a "None" option that is interpreted as a choice threshold, where respondents prefer none of the three listed product concepts. Three randomly created product-concepts were part of every choice set plus the "None option". Therefore, respondents could choose one option out of four (three alternative product concepts or the "None option", Tables A1 and A2). Thereby the "None" option represented the influence on the utility of not choosing a shown product.

3.2.3. Factor Analysis

All factors were examined for their construct validity and internal reliability. Factor analysis is often used to reduce the dimensions, measured through certain defined items. Through factor analysis, item-groups of the measured scales that highly correlate with each other are found and can be aggregated in one influencing factor. We conducted the principal components analysis as extraction method used within the factor analysis. We applied the rotation method Varimax with Kaiser-normalization and the rotation was converged in 5 iterations. The variable "prior behavior" was not included in the factor analysis as it was measured by one item only. Table 3 shows the derived factors and the statements used for covariate-estimation in this study. The results of the original factor analysis are displayed in the Appendix A (Table A3). No evidence of multicollinearity was found. All factor loadings are reflected in the factors given (Table 3).

3.2.4. Mathematical Approach for the Estimation of the Covariates

We estimated the part-worths of the CBC data using the Hierarchical Bayes statistic (HB), which requires repeated choices per respondent within the CBC as it is necessary to measure variation within and between the respondents' choices. The HB models respondents' preferences as a function of an upper-level model and a lower level individual model [75]. The upper-level model describes the part-worths β_i distributed with means α and covariance matrix D, subscript i is the respondent, as shown in Equation (1).

$$\beta_i \sim Normal(\propto, D) \tag{1}$$

The lower-level model is described by Equation (2) and estimates the utility u_k that respondent i gains through the choice for alternative k.

$$u_k = x'_k \beta_i \tag{2}$$

Furthermore, the probability p of the choice for alternative k made by respondent i is estimated by Equation (3).

$$p_k = \frac{\exp(x'_k \beta_i)}{\sum_j \exp(x'_j \beta_j)} \tag{3}$$

The integration of the model for the psychographic features into the HB-logit-choice-model takes place by the assumption through the regression Equation (4). Where Θ is a matrix (q by b) of regression parameters, z_i is a q vector of covariates, and ε_i is a b vector of random error terms and D is a covariance matrix, the output β_i displays the part-worths of an analyzed attribute-level for respondent i [75].

$$\beta_i = \Theta' z_i + \varepsilon_i \; where \; \varepsilon_i \sim Normal(0, D) \tag{4}$$

We conducted the CBC with 8 random tasks and 2 fixed tasks using the default balanced overlap estimation. The HB had 40,000 iterations using 30,000 for the statistical analysis. The estimation was computed using only the random tasks. Six covariates were included into the statistical estimation.

Table 3. Items and factors used for covariate-estimation *.

Factors & Item-Scales of Factors	Statements	Possible Answers	Cronbachs Alpha	Source
Prior behavior Product experience	Have you ever deliberately opted for bioplastic products?	1 = No; 2 = Yes	n.a.	Reformulated according to [15,17]
Factor 1 Green Consumer Values	Please indicate to what extent you agree with the following statements. 1. It is important to me that the products I use do not harm the environment. 2. I consider the potential environmental impact of my actions when making many of my decisions. 3. My purchase habits are affected by my concern for our environment. 4. I am concerned about wasting the resources of our planet. 5. I would describe myself as environmentally responsible. 6. I am willing to be inconvenienced in order to take actions that are more environmentally friendly.	1 = I do not agree at all; 2 = I rather do not agree; 3 = partly; 4 = I rather agree; 5 = I totally agree	0.895	[31]
Factor 2 Altruism	How important is to you: A1) To help other people A2) To serve mankind A3) To share what you have A4) To give to others A5) To be unselfish	1 = not important at all; 2 = rather not important; 3 = maybe important; 4 = rather important; 5 = important in any case	0.845	[73]
Factor 3 Attitude towards bioplastics	Below you can see statements from various organizations on bioplastics. Please state per statement whether you would convince them or prevent them from supporting increased use of bioplastics. If the statement does not matter for your rating, select "I do not care." 1. The long-term goal is to produce bioplastics from non-edible plant residues. 2. Bioplastics can withstand just as much as conventional plastics. 3. The carbon footprint of bioplastics is lower than that of conventional plastics. 4. The plants for bioplastics come from non-regional cultivation.	1 = I do not agree at all; 2 = I rather do not agree; 3 = I do not care; 4 = I rather agree; 5 = I totally agree	0.782	Reformulated according to [17]

Table 3. *Cont.*

Factors & Item-Scales of Factors	Statements	Possible Answers	Cronbachs Alpha	Source
Factor 4 Trust (KUSIV3 and trust-item of BFI-10 short scale)	KUSIV3: The next questions are about your attitude towards other people. Please indicate to what extent you agree with each statement. 1. I am convinced that most people have good intentions. 2. You cannot rely on anyone these days. 3. In general people can be trusted.	1 = don't agree at all 2 = agree a bit 3 = agree somewhat 4 = agree mostly 5 = agree completely	0.747	[47]
	BFI10-Item: 4. How well do the following statements describe your personality? I see myself as someone who is generally trusting	1 = disagree strongly 2 = disagree a little 3 = neither agree nor disagree 4 = agree a little 5 = agree strongly		[74]
Factor 5 Innovation-friendly	Please indicate to what extent you agree with the following statements. 1. I am excited to try out new products. 2. I appreciate having novel products. 3. I like to be confronted with new ideas.	1 = I do not agree at all; 2 = I rather do not agree; 3 = partly; 4 = I rather agree; 5 = I totally agree	0.810	[13,59]

Note: Most of the items were used in the study of Klein et al. [67] focusing on different research questions.

4. Results and Discussion

Below, we show the relative importance and the utilities of the tested attribute levels as computed through the HB estimation and compare our results with the existing literature. Additionally, we show the estimation of the covariates in Section 4.3 and discuss their influence on consumers' preferences for selected attributes of bio-based apparel.

4.1. Relative Importance of the Attributes

Table 4 shows the average relative importance values of the attributes of the functional jacket based on the HB estimation. Price was the attribute with the highest average relative importance (45.3%). The relevance of price for green apparel is well known and supported by previous studies described in the literature [27,70,71]. Product certificate showed the second highest average importance, which indicates the importance of labeling and information for many consumers. This is also in line with other studies [71,76]. The average relative importance of the attributes "percentage of bioplastic in fabric" and "origin of resource" had very similar values. The least important attribute was the "biogenic resource" itself. It seems that abstract information provided through certificates was more valuable to consumers than detailed information like the exact source of the biomass. Several previous studies have confirmed the importance of eco-labels for the awareness and the consumption of green products [20,21,53,71,77–79].

Table 4. Average importance values of attributes of a bio-based functional rain jacket.

Attributes	Average Importance (%)	Standard Deviation
Percentage of bioplastic in fabric	13.6	8.6
Biogenic resource	8.4	5.7
Origin of resource	13.6	9.3
Product certificate	19.1	9.4
Price	45.3	17.9

Note: Source: own estimation.

4.2. Utilities of the Attribute-levels

Table 5 displays the part-worth utilities of the levels of the analyzed attributes. Our results show that 100% bioplastic in the fabric had the highest marginal utility within this attribute. The highest utility within the biogenic resource attribute was for the level chipped wood. Forest wood as a raw material is not directly related with the production of food crops on arable land and therefore does not contribute to the food-versus-fuel dilemma. This could be the reason for respondents' preference for biomass from this source in comparison to maize or potatoes. The European Union as location for the raw material plants had the highest marginal utility for respondents and was preferred over all overseas locations. This finding is also supported by Scherer et al. [13,14], who found a preference for national or regional production of raw material plants used for bioplastic products. The marginal utilities of the product certificates "free of pollutants", "climate protection" and "fair production" ranged from 17 to 20, whereas the level "no certificate" had a high negative utility value. This supports the value of certificates for informing consumers about the specific characteristics of green products, which is in line with previous studies [29,46,76,80]. The highest marginal utility within the price attribute was found for the lowest price of 69 € followed by 109 €. Prices are often important for consumer choices and the majority of respondents also preferred low prices also for bio-based products [13,14]. The "None" option, meaning that no product was chosen in the CBC, had a mean utility value of 37.4. This means that the sum of the utilities of a product concept with the displayed attributes and levels must show a higher value than the utility of the "None" option so that consumers prefer this concept. Otherwise, they would decide not to choose any of product alternatives offered in the CBC.

Table 5. Utilities of the attribute levels of a bio-based functional rain jacket.

Attributes	Attribute-Levels	Average Utilities (Zero-Centered Diffs)	Standard Deviation
Percentage of bioplastic in fabric	100%	29.97	26.54
	50%	1.80	11.30
	20%	−31.76	25.36
Biogenic resource	Potatoes	−2.53	15.64
	Chipped wood	6.44	27.41
	Sugar cane	−0.06	15.72
	Corn	−3.84	16.39
Origin of resource	South America	−11.57	15.39
	European Union	36.95	35.91
	United States	−6.01	15.08
	Asia	−19.36	21.24
Product certificate	Free of pollutants	20.37	22.42
	Climate protection	17.74	20.67
	Fair production	18.09	24.36
	No certificate	−56.20	31.67
Price	349 €	−116.06	54.12
	239 €	−35.47	36.27
	109 €	61.53	27.94
	69 €	90.00	68.42
None Option		37.44	145.42

Note: Source: own estimation.

4.3. Influences of the Covariates

Covariates interpretation: As displayed in Table 3, the psychographic scales of the survey were factorized and the scores for each factor were implemented as covariates in the HB estimation. The results of this analysis are shown in Table 6 and illustrated in Figure 1. The intercept shows a respondent's individual utility considering the zero centered means of all factors. Additionally, the intercept shows the characteristic of having prior product experience, whereas the covariate product experience shows the theta-values of having no prior experience. We considered the significant theta-values of the included covariates for the interpretation. Significant positive theta-values lead to an increase of the individual utility of a respondent for a specific attribute-level if the measured value of the covariate is above the mean given all other variables are held constant. For example, a person's utility for the attribute-level "100% bioplastic" was estimated as shown in Equation (5). The figure of the intercept (1.13) added by the product of the theta-weight (0.36) and the measured value of "attitude towards bioplastics" of an individual results in the utility of the attribute level for the individual.

$$\beta_{100\%\ bioplastic} = 1.13 + 0.36 \times Attitude\ towards\ bioplastics \quad (5)$$

Table 6. Theta-parameter estimation of the covariates.

Attributes & Levels	Intercept	Product-Experience	Green Consumer Values	Altruism	Attitude towards Bioplastic	Trust	Innovation-Friendly
Percentage of Bioplastic							
100%	1.13 ***	0.05	0.21 ***	−0.01	0.36 ***	0.02	0.21 ***
50%	0.00	0.10	0.02	0.01	0.02	0.02	0.00
20%	−1.14 ***	−0.15	−0.23 ***	0.00	−0.38 ***	−0.03	−0.21 **
Biogenic resource							
Potatoes	0.38 *	−0.56 ***	0.02	−0.04	−0.18 ***	−0.12 *	−0.03
Chipped wood	0.22	0.04	0.00	0.04	0.15 *	0.04	−0.09
Sugar cane	−0.43 **	0.49 **	0.08	0.08	0.04	−0.01	0.03
Corn	−0.17	0.04	−0.10	−0.07	0.00	0.09	0.09
Origin of resource							
South America	−0.59 ***	0.18	−0.02	0.07	0.05	−0.12 *	0.04
European Union	1.23 ***	0.15	0.16 *	0.01	0.02	0.11	−0.07
United States	0.00	−0.26	−0.11	−0.06	0.06	0.11 *	0.05
Asia	−0.65 ***	−0.06	−0.03	−0.01	−0.13 *	−0.09	−0.02
Product certificate							
Pollutant free	0.84 ***	−0.13	0.09	0.18 **	−0.01	−0.11 *	−0.08
Climate protection	0.65 ***	0.05	0.08	0.07	0.13 *	−0.02	−0.05
Fair production	0.40 *	0.34 *	0.09	−0.05	0.19 **	0.18 **	0.15 **
Without certificate	−1.89 ***	−0.26	−0.26 ***	−0.20 **	−0.31 ***	−0.05	−0.02
Price							
349 €	−4.23 ***	−0.59 *	0.66 ***	0.52 ***	−0.26 *	0.00	0.11
239 €	−1.27 ***	−0.30	0.19 *	0.21 **	−0.05	0.09	0.25 ***
109 €	2.12 ***	0.43 *	−0.12	−0.20 **	0.25 ***	0.08	−0.08
69 €	3.38 ***	0.45	−0.72 ***	−0.53 ***	0.05	−0.17 *	−0.28 **
None option							
None	−0.25	2.22 ***	−0.53 ***	−0.50 ***	−0.80 ***	−0.67 ***	−1.04 ***

Note: * significant at the level 0.05; ** significant at the level 0.01; *** significant at the level 0.001.

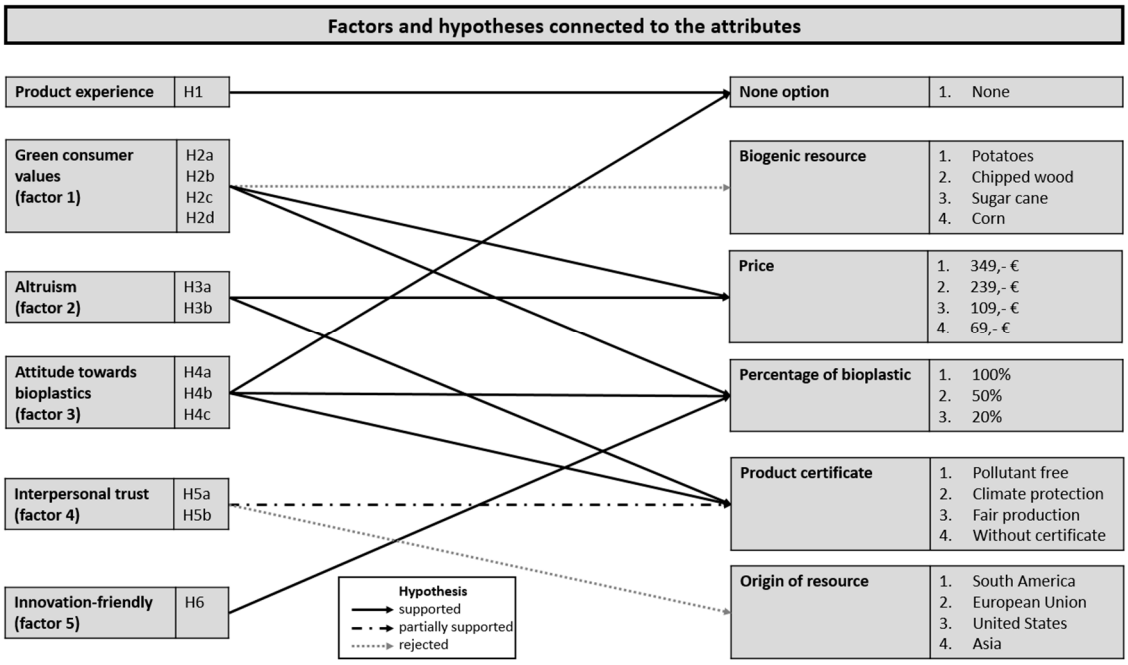

Figure 1. Summary of results of the testing of the hypotheses.

Fit-statistics: The root likelihood (RLH) is the geometric mean of the predicted probabilities for the concepts the respondent actually chose. This data set has four alternatives per choice task, including the "None" option. The expected RLH value for a chance model would be 0.25. Our computed value of 0.700 for 40,000 iterations is interpreted to be 2.8 times better than the chance level. The percent certainty typically varies between 0 and 1, with a value of 0 meaning that the model fits the data at only chance level, and a value of 1 meaning perfect fit. Our percent certainty value of 0.743 indicates that the log likelihood is 74.3% of the way between the value that would be expected by chance and the value for a perfect fit [81].

Product experience: As stated in Section 2, prior product experience with green products can be regarded as an influencing factor for purchasing bioplastic products. The theta value of the "None option" indicates a highly significant positive value for respondents without product experience and illustrates that these respondents tend to reject bio-based rain jackets. This finding is consistent with previous studies considering actual green behavior based on prior behavior [27–29,82]. Therefore, hypothesis H1 "No prior product experience with bio-based apparel decreases the probability of consumers' preferences for it" is supported.

Green Consumer Values: The utility for 100% bioplastics in the fabric increases with higher GCV as shown in Table 6. Additionally, a significant decrease in the utility for 20% bioplastics in the fabric is seen as GCV increases. The influence of GCV are in line with previous studies considering the consumption of green products and the influence of GCV product choice [13,15,31]. Hence, we assume that higher GCV lead to a higher preference for green functional clothes. Thus, hypotheses H2a "Higher GCV increase consumers' preferences for a high percentage of bioplastic in the fabric of bio-based apparel" and H2b "Lower GCV decrease consumers' preferences for a high percentage of bioplastic in the fabric of bio-based apparel" are supported. We also expected consumers with a higher GCV to prefer chipped wood over other resources. We postulated that consumers with green attitudes are more sensitive to the food-versus-fuel-dilemma identified in previous studies [32–34]. However, our results show no evidence for hypothesis H2c "Higher GCV increase consumers' preferences for resources with a perceived low food versus fuel dilemma in the case of bio-based apparel", which we therefore reject. Additionally, with increasing GCV, the utilities for the price-levels 349 € and 239 € increase, whereas the utility for the price level of 69€ decreases. The influence of GCV on respondents

accepting higher prices was also found in previous studies [13,18,19]. Hence, hypothesis H2d "Higher GCV decrease the relevance of low prices for bio-based apparel" is supported.

Altruism: With increasing levels of altruism, the utilities for the higher price-levels increase, whereas the utilities for the lower price-levels decrease (Table 6). Thus, the more altruistic a person is, the less price sensitive she or he is with respect to bio-based products. This result is also in line with previous studies of Scherer et al. [15], Stern et al. [39], Lusk et al. [43] and Thøgersen and Ölander [83] who found that altruistic values are predictors for a higher willingness to pay for more environmentally-friendly products. This supports hypothesis H3a "Higher altruism decreases the relevance of low prices for bio-based apparel". Additionally, with increasing levels of altruism, the utility for the certificate "free of pollutants" increases. In contrast, the higher the level of altruism of a respondent, the lower the utility for a rain jacket without a certificate is. Thus, hypothesis H3b "Higher altruism increases consumers' preferences for a certification of bio-based apparel" is supported.

Attitude towards bioplastic: A higher positive attitude towards bioplastics increases the utility for 100% bioplastics in the fabric, whereas the utility for 20% bioplastic decreases (Table 6). This result shows that a strong attitude towards bioplastics is positively related to the preference for functional clothes made of bioplastic. In addition, the utility of the "None option" of the covariate attitude towards bioplastic shows a negative utility value. Therefore, hypotheses H4a "Higher attitude towards bioplastics increases consumers' preferences for bio-based apparel" and H4b "Higher attitude towards bioplastics increases consumers' preferences for a high percentage of bioplastic in the fabric of bio-based apparel" are supported. With an increasingly strong attitude towards bioplastic, the utilities for the certificates "protects the climate" and "fair production" increase. In contrast, a significant decrease in the utility for no certificate is seen for an increasingly strong attitude towards bioplastic. Thus, hypothesis H4c "Higher attitude towards bioplastics increases consumers' preferences for a certification of bio-based apparel" is supported.

Trust: The higher the level of trust, the higher the utility for a certificate "fair production" is. In contrast, the utility for a certificate stating "free of pollutants" decreases. Thus, hypothesis H5a "Higher trust increases consumers' preferences for a certification of bio-based apparel" is partially supported. Padel and Foster [56] revealed that locally grown organic food generates higher trust than products from abroad. Furthermore, previous studies have found the influence of trust on familiarity and the origin of products for the choice for them [57,58]. However, we could not find a relation between a low levels of trust and lower preferences for bio-based apparel produced abroad. Therefore, hypothesis H5b "Lower trust increases consumers' preferences for bio-based apparel using biomass sources that are produced nationally" is rejected.

Innovation-friendly: The higher the levels of innovativeness, the higher the utilities for 100% bioplastic and the lower the utility for 20% bioplastic in the rain jacket (Table 6). Thus, hypothesis H6 "Higher innovation-friendly increases consumers' preferences for a high percentage of bioplastic in the fabric of bio-based apparel" is supported. This result is in line with previous studies showing that consumer innovativeness promotes the adoption of innovative green products [13,59,62].

5. Methodological Limitations, Conclusions and Implications

Methodological limitations: As with all empirical work, this study is not without some limitations. First, respondents might have been confused by the relatively high prices of the rain jacket. However, these prices represent the current market prices of functional rain jackets in Germany in a realistic way. We even found higher prices for a superior quality jackets. Second, selection bias through the online access panel cannot be excluded, although it seems unlikely. The quotas were set considering important sociodemographic characteristics, which should ensure that a representative sample is obtained from the crowd of the panel. In this sense, the results of this study are assumed to be representative for the population in Germany. Third, all responses were self-reported and the buying process was simulated by the CBC and was therefore hypothetical. In future, a study investigating a real market situation may be a promising approach to identify further important attributes, such as style of the product

or other haptic aspects of bio-based apparel. Fourth, this study was conducted in an online access panel in Germany and an international comparability of the results always faces possible influences of cultural differences related to the market or society of other countries. Therefore, results of this study should be interpreted with caution when transferring them to other countries. Future studies in other countries could improve insights on consumer's preferences for bio-based apparel in an international context. Fifth, panel-members seem to be familiar with questionnaires, which possibly influences their responses [84,85]. Conspicuous responses were cleaned from the data set as mentioned in Section 3.1 in an attempt to minimize the potential effect. In conclusion, the applied methods and their statistical analysis show results that are strongly related to previous studies. In addition, 9 of 12 hypotheses are supported and one more is partially supported.

Conclusions and implications: The major contribution of this study is to reveal the factors influencing consumers' preferences for bio-based apparel. We examined the importance and the utilities of the attributes of bio-based apparel and investigated the factors significance and their influential strength. In this study, prior product experience, GCV and attitudes towards bioplastics are the strongest factors promoting the preference for bio-based apparel. Blesin et al. [9] stated that only 12% of German consumers have product experience with bioplastics. Hence, it is advisable to increase the perception of bioplastic products in the general public and address further marketing efforts to interested groups.

Since product experience has a significant influence on the preference for bio-based apparel, it is necessary to increase the awareness of bioplastics to promote bio-based apparel. This might have the effect that more consumers intend to buy bio-based apparel and gain product experience, which promotes a preference for bio-based apparel. Possible instruments to increase the awareness are the presentation at the point of sale for better product attention, a targeted communication for specific product segments or nudging. Furthermore, policy makers should elaborate a clear definition of bioplastics and improve labeling of bioplastic products to support the awareness of them.

Consumers with higher preferences for bio-based apparel show higher GCV and attitudes towards bioplastics. Moreover, a European origin of the vegetable raw materials used is preferred by green consumers as well as high levels of bioplastics in the fabric. Thus, consumers with these preferences should be strengthened in their confidence in bio-based products. A largely positive attitude towards bioplastics in the population should be maintained and—if possible—expanded. This can be supported above all by clear claims and transparent value chains. This also includes recognizable labeling, verified life cycle assessments and standards. Policy should set the rules in these areas, and state institutions should be responsible for reviewing these tools to create security, reliability and trust among consumers.

Finally, the identified influencing factors should be taken into account and used in the "emotional" design and the tonality of communication measures. It is advisable to put positively assessed product properties of bioplastic products in the foreground and consider them in communication measures.

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Appendix A

Table A1. CBC introduction text.

First, please put yourself in the following situation: You want to buy a new rain jacket. You are looking for a high-quality product from a brand you know in an outdoor clothing store. After a short search, you will find what you are looking for and have the choice between different alternatives. Size, color, cut and function of the jacket meet your expectations. The seller points out that some jackets are made of bioplastics. He goes on to say that, various renewable raw materials were used instead of petroleum for its production, but that no impairment of product quality is to be expected. He advises you further that the raw materials come from different countries of origin, and there are also various certifications on the rain jackets, which say something about production or material of functional clothing.

Table A2. Choice set (example for random task).

	Alternative 1	**Alternative 2**	**Alternative 3**	
Percentage of bioplastic	100%	20%	50%	NONE: I would not choose any of these.
Raw material	Sugar cane	Potatoes	Corn	
Origin of resource	USA	Asia	EU	
Certification	Free of pollutants	No certificate	Fair production	
Price	239 €	349 €	109 €	

Table A3. Rotated covariance-matrix of factor analysis.

Item	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
Green Consumer Values (1)	0.741	0.251	0.121	0.086	0.094
Green Consumer Values (2)	0.667	0.158	0.316	0.036	0.006
Green Consumer Values (3)	0.824	0.162	0.096	0.027	0.111
Green Consumer Values (4)	0.804	0.106	−0.006	0.062	0.037
Green Consumer Values (5)	0.835	0.154	0.123	0.052	0.069
Green Consumer Values (6)	0.804	0.155	0.074	0.026	0.099
Innovation-friendly (1)	0.102	0.059	0.103	0.059	0.875
Innovation-friendly (2)	0.034	0.068	0.003	0.025	0.879
Innovation-friendly (3)	0.170	0.148	0.162	0.049	0.743
BFI10 (1 item on trust)	0.008	0.246	−0.040	0.600	0.030
KUSIV3 (1)	0.102	0.141	0.021	0.833	0.006
KUSIV3 (2)	0.019	0.029	0.070	0.714	0.035
KUSIV3 (3)	0.080	0.128	0.036	0.824	0.062
Altruism (1)	0.165	0.719	0.134	0.151	0.094
Altruism (2)	0.240	0.614	0.000	0.186	0.006
Altruism (3)	0.161	0.793	0.014	0.119	0.081
Altruism (4)	0.135	0.843	0.075	0.126	0.128
Altruism (5)	0.178	0.772	0.100	0.057	0.035
Attitude towards bioplastics (1)	0.147	0.071	0.774	0.039	0.052
Attitude towards bioplastics (2)	0.128	0.059	0.749	0.023	0.038
Attitude towards bioplastics (3)	0.052	0.040	0.728	0.029	0.119
Attitude towards bioplastics (4)	0.122	0.076	0.794	−0.002	0.047

Extraction method: principal components analysis; rotation method: Varimax with Kaiser-normalization; the rotation is converged in 5 iterations.

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