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Consumer Preferences in Germany for Bio-Based Apparel With Low and Moderate Prices, and the Influence of Specific Factors in Distinguishing Between These Groups

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Bioplastics are a potential alternative to conventional plastics when it comes to reducing the use of the fossil resource of crude oil. There have been so far very few studies on the consumption of bio-based apparel and consumer preferences relating to it. Within this study, an online survey was conducted with 1,673 participants that is representative of the German population over the age of 16, including a choice-based consumer experiment with a bio-based rain jacket. Using latent class analysis, two clusters of consumers (39% of respondents) were identified with acceptance of moderate prices for such bio-based products. The other 61% of consumers showed preferences for the lowest prices of the tested bio-based rain jacket. A discriminant analysis revealed that the intention to purchase bio-based apparel, the Green Consumer Value and subjective norms of bio-based apparel were the strongest significant factors when distinguishing between consumer groups of bio-based apparel with a "preference for a low price" and those showing "acceptance of a moderate price." This study helps to better illuminate the heterogeneity of consumer preferences for bio-based apparel related to pricing strategies and supports building up of a supply chain for such products.

Keywords: bio-based apparel, choice based conjoint analysis, consumer preference, environmental behavior, consumer studies, price, sustainable product

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INTRODUCTION

The consumption of apparel has increased worldwide. A large proportion of apparel is made from conventional plastics, which causes substantial environmental problems, not least the fossil carbon dioxide footprint that is increasing every year (Textile Exchange, 2017; Chrobot et al., 2018; UNECE, 2018; UNFCCC, 2018; Šajn, 2019). This is why sustainable or green apparel is becoming a frequent topic of discussion as an alternative strategy that can help to protect the climate (Muthu, 2014; Balster, 2019; Klein, 2019). The global market for apparel is increasing steadily (Fashion United, 2017; CO Data, 2018; Šajn, 2019). In this context, Germany plays a leading role in Europe and produces more than 25% of all technical textiles (Euratex, 2019). Technical textile production is mainly based on crude oil. However, since petroleum is a fossil fuel and also the primary factor responsible for the heating of the earth's atmosphere, a more appropriate aim would be to dissolve

the link between consumption and the use of fossil resources and to move over to using renewable resources. This includes plastics. In addition, plastic apparel enables the formation of a circular economy, as both conventional plastics and bio-based plastics used for textiles lend themselves to recycling (Textile Exchange, 2017). In order to mitigate the effects of carbon dioxide emissions on the atmosphere and instead store carbon in textiles by using plant material as a resource, it is essential that the manufactured garments are not fast fashion items and that they are suitable for frequent recycling (Muthu, 2014; Rana et al., 2014; Fuhr et al., 2019; Šajn, 2019). In addition, strategies are needed for preventing the release of microplastics during washing, such as using washing machine filters (Leinfelder and Regensburger, 2019).

So far, the market share of bio-based plastics in the textile sector is comparatively low, as the associated manufacturing industries are still in their development phase (Šajn, 2019). Up until now, there have only been few studies looking into consumer decisions, behavior and intentions regarding the consumption of green apparel or bio-based products (Hustvedt and Bernard, 2008; Hustvedt and Dickson, 2009; Niinimäki, 2010; Koszewska, 2013; Austgulen, 2016; Nam et al., 2017; Scherer et al., 2017, 2018a,b; Klein et al., 2019, 2020), even though consumer preferences and choices are an essential factor when it comes to developing innovative and sustainable products (Austgulen, 2016). Brand and Rausch (2020) found that very green consumers tended to prefer the influence of sustainability-related attributes, such as materials, labels or country of origin, while price was by far the most influential driver for less green consumers when choosing bio-based outdoor apparel. Furthermore, Herbes et al. (2018) revealed that consumers are less concerned with renewable origins and almost not concerned at all with activities related to production, transportation and retail use. In a review, Joshi and Rahman (2015) found that consumer environmental awareness and the functional attributes of sustainable products emerged as the two most important determinants of consumers' green purchasing behavior. In addition, they summed up that a high price negatively influences the purchase intention and behavior of sustainable products. Lynch et al. (2017) revealed that acceptance and support for bio-based technologies increases as consumers become more engaged with these technologies, and becomes even stronger when they identify opportunities for direct personal benefit. Additionally, Choi et al. (2020) show that U.S. consumers who care about environmentally friendly production and recycling practices are willing to pay a premium for bio-based batteries.

Additionally there are first hints in previous studies that consumer estimations differ with respect to pricing of bio-based products. Several studies found that the relevance of prices for product preferences of bio-based products differ between committed environmentally friendly consumers and those with less environmentally friendly attitudes (Kurka, 2012; Kainz, 2016; Scherer et al., 2018b). Hustvedt and Bernard (2008) also found that participants in an experimental auction displayed a greater willingness to pay for organic socks. Additionally, several studies showed an increase in utility of medium prices of bio-based products in particular for consumers with more environmentally friendly attitudes (Scherer et al., 2018b; Brand and Rausch, 2020, Niedermeier et al., 2021).

However, no recent studies have focused on differing consumer estimations related to price variations of bio-based products although the existing literature shows the high relevance of prices for purchasing of bio-based products (Hartmann and Apaolaza-Ibáñez, 2012; Joshi and Rahman, 2015; Chekima et al., 2016; Aschemann-Witzel and Zielke, 2017). Therefore, this study aims to contribute to this research area by analyzing the following research questions:

- Which consumer segments can be identified in terms of product pricing for bio-based apparel?
- What are the factors that influence consumers' price preferences for different bio-based apparel and play a role in distinguishing between different consumer groups?

This study aims to identify the potential heterogeneity of consumer perceptions regarding different prices of bio-based apparel, taking into account the associated environmental benefits. It also identifies those factors that play a significant role in distinguishing between different groups of bio-based apparel consumers, i.e., those with a "preference for a low price" and those with an "acceptance of a moderate price."

The paper provides information on the key predictors of consumers' green purchasing behavior toward green apparel. In this way, it will support policymakers and company managers in formulating and implementing strategies to promote purchasing of green products.

FACTORS INFLUENCING CONSUMERS' PRICE PREFERENCES WITH BIO-BASED APPAREL

This study investigates factors that influence consumers' price preferences relating to bio-based apparel. For this purpose, a review of the scientific literature was conducted to determine relevant variables relating to price preference and particular attributes of bio-based apparel. The following section therefore provides background information and defines the independent variables.

Sociodemographic Variables: Age, Gender, Education

Sociodemographic characteristics are often employed in consumer research studies, but their inflow toward green consumption tends to be low (Straughan and Roberts, 1999; Casimir and Dutilh, 2003; Diamantopoulos et al., 2003; Tanner and Wölfing Kast, 2003; Hess et al., 2013). Klein et al. (2019) showed a weak influence of sociodemographic factors on purchase intention of bio-based products what was supported by mixed results of Niedermeier et al. (2021). Due to the ambiguous results presented in the studies reviewed, it is assumed that sociodemographic characteristics (in this study represented by age, gender, and education) have no influence on price preferences relating to bio-based apparel.

Altruism

Altruism or prosocial behavior as defined by Batson and Powell (2003) can be a precursor to eco-friendly consumption. Evidence of this has been reported in several studies. For instance, Lusk et al. (2007) found that people who are more altruistic are willing to pay more for environmentally certified pork. Hefner (2013) identified altruism as one of the drivers of eco-friendly behavior. Straughan and Roberts (1999) also found a strong correlation between altruism and environmentally friendly consumer behavior. In addition, Stern et al. (1993) concluded that social altruism and environmentally friendly behavior are related (as measured by the predicted willingness to pay higher gas prices or income taxes). Teng et al. (2015) and Pfattheicher et al. (2016) showed that altruistic behavioral intentions are positively related to eco-friendly buying intentions. Hence, altruism is seen as a factor that determines consumers' willingness to purchase bio-based apparel and that influences them to accept higher prices for bio-based apparel.

Subjective Norms of Bio-Based Apparel

Individuals tend to behave in a particular way when they believe that they are expected to do so by certain people. These so-called subjective norms are an element of the theory of reasoned action proposed by Ajzen and Fishbein (1980). It is a well-known influencing factor that is frequently used for measuring environmentally friendly behavior. For example, Teng et al. (2015) reported a positive influence of subjective norms on purchase intentions for green products. In addition, several other studies have demonstrated the influence of subjective norms (Tarkiainen and Sundqvist, 2005; Hefner, 2013; Mishra et al., 2014; Untaru et al., 2016). Nam et al. (2017) found that subjective norms relating to green sportswear had a positive impact on the intention to purchase green sportswear. This is supported by Klein et al. (2019) who showed that subjective norms increase the purchase intention of bio-based products. Based on the previous findings it is assumed, if subjective norms have a stronger influence, consumers will tend to accept a moderately higher price for bio-based apparel.

Innovativeness

The power of consumers to be innovative, as discussed by Tellis et al. (2009) is an important driver in the introduction of environmentally friendly product innovations (Jansson, 2011; Englis and Phillips, 2013). Osburg et al. (2016) found that the likelihood of a consumer choosing wood-plastic composites over conventional plastics correlates with the consumer's innovativeness. In addition, Scherer et al. (2017) noted that ecologically sensitive consumers are more innovative than consumers of conventional plastic. Klein et al. (2020) showed that more innovative consumers are more in favor of bio-based products. Therefore, an individual's interest in innovation seems to have a positive impact on their decision to purchase eco-friendly apparel. Thus, it is claimed that a higher level of consumer innovativeness leads to increased acceptance of a moderate price for bio-based apparel.

Green Consumer Values (GCV)

Haws et al. (2014) developed a set of environmental conservation attitudes and values with which to examine the relationship between an individual's green values and his or her eco-friendly purchasing decisions. They found evidence of a correlation between GCV and consumer buying intentions for green products. This was also reported for similar items by Kurka (2012) and Scherer et al. (2017). Niedermeier et al. (2021) showed that GCV act as a driver for purchase of bio-based products. Furthermore, GCV can be used to significantly separate green consumer segments from others in relation to bio-based products (Niedermeier et al., 2021). Therefore, it is assumed that increasing GCV would also affect consumers' acceptance of moderate prices for bio-based apparel.

Attitude Toward Bioplastics

Hartmann and Apaolaza-Ibáñez (2012) and Teng et al. (2015) have shown that consumers' concern for the environment has a positive impact on their intention to purchase green products. Recent studies by Rumm et al. (2013), Rumm (2016), and Scherer et al. (2017) also found a link between environmental attitudes and choice-based behavior with regard to bio-based products. Klein et al. (2019) found a strong influence of attitudes toward bioplastics on the purchase intention of bio-based products. Based on these findings is assumed that an attitude of increased acceptance toward bioplastics affects consumers' willingness to accept moderate prices for bio-based apparel.

Product Experience Made With Bio-Based Products

Lee et al. (1995) and Young (2000) claimed that past recycling behavior evolves into future recycling behavior. Further evidence of the impact of product experience on purchase intent with green products has been provided by Young et al. (2009). Blesin et al. (2017) showed that past product experience leads to a greater purchase intention for bio-based products. Additionally, Klein et al. (2019, 2020) showed that previous product experiences increase the probability of purchasing bio-based products. Therefore, previous consumer behavior is expected to affect consumers' acceptance of moderate prices for bio-based apparel.

Interest in Bioplastics

Rumm et al. (2013) and Schleenbecker and Hamm (2013) found that product and resource information has a positive impact on both green products themselves and the decision to purchase them. Similarly, McDonald et al. (2009) found that green consumers seek out information about sustainable products. Klein et al. (2019) showed that more interest in bioplastics significantly increases the purchase intention of bio-based products. Thus, it is claimed that a higher influence of interest in bioplastics leads to consumers accepting a moderate price for bio-based apparel.

Purchase Intention

The intention to buy environmentally friendly products can be regarded as a form of behavioral purpose, which refers to the

subjective ability of an individual to engage in behavior. This can be influenced by behavioral attitudes (Ajzen and Fishbein, 1980). Morrison (1979) showed that purchase intent predicts buying behavior. Green consumption has been analyzed in previous studies on the basis of purchase intent (Laroche et al., 2001; Hartmann and Apaolaza-Ibáñez, 2012; Nam et al., 2017). In line with these studies, it is assumed that purchase intention is a relevant influencing factor toward consumers' acceptance of moderate prices for bio-based apparel.

Altogether, a broad range of studies can be identified that have dealt with factors that influence consumers' price preferences for green or bio-based products (**Table 1**). However, most of these studies only consider single items in this context, so that there is need for a comprehensive study in this area of research.

METHODS

Data

The data was collected in June 2016 by a professional market research company that was commissioned to recruit respondents through an online access panel. Participants received little financial incentive to complete the full survey. Web surveys are cheaper than other survey methods and enable faster data collection (Evans and Mathur, 2005). The representative group of the German population over the age of 16 was based on the socio-demographic characteristics as indicated by the German sample survey 2015 (German Federal Statistical Office, 2015). The quotas were determined by gender, age, education and population of the city of residence (**Table 2**). Once the data was collected, the data was purged relating to unworkable responses (straight-liners, Christmas tree behavior, conflicting answers, incorrectly answered test questions, etc.). After statistical evaluation, there remained 1,673 respondents. Further data management and analysis were performed using Sawtooth 8 (Sawtooth Software Inc., 2015) and SPSS 23 (IBM Corp., 2015). The independent variables and covariates used in the CBC analysis, the latent class analysis and the discriminant analysis were derived from the literature review. They were mainly measured on the basis of 5-point Likert scales. All the factors and variables used are listed in **Table 4**.

Choice Based Conjoint Analysis

Choice-based Conjoint Analysis (CBC) is a widely used and valid method of examining preferences for either innovative or existing products (Eggers and Sattler, 2011; Louviere and Woodworth, 2018). Although the decisions measured do not necessarily result in purchasing behavior, they shed light on the purchasing motivation for certain products, for example, on the basis of important properties that consumer products offer as well as the willingness of consumers to pay. In this sense, CBC experiments are able to simulate purchase situations of existing and in particular new products. A respondent's preference is based on the product concepts chosen in the CBC. A set of attributes with realistic and existing occurrences (levels) is selected (**Table 3**). The product concepts are either constructed randomly (random tasks) or chosen selectively (fixed tasks). The defined tasks form part of the validation of the method. The respondents rate each attribute level by selecting the depicted product concepts. The utility function is used to translate decisions made into the consumer's perceived preferences and to predict buying decisions (Eggers and Sattler, 2011). CBC analysis is based on the random utility theory of McFadden (1986). The random utility model considers two parts to utility U in choice situation i of a choice set C_q, the deterministic part of utility V_{qi} and the random part of utility ε_{qi} (1).

$$U_{qi} = V_{qi} + \varepsilon_{qi} \quad (1)$$

Attributes and Levels, Product-Concepts

CBC experiments require a set of attributes with different levels, for implementation of the product concepts created. In a CBC analysis, attributes are sources of utility because the level of utility for a respondent depends on the level of attributes. The contribution of a particular attribute to the total utility of an alternative is called "part-worth." As utility is an ordinal concept and the relative utility compared to alternatives in the same choice set is of interest, the reference utility is used in this study.

In this study, attributes were considered that either already exist or can potentially play a role in the German market. The attributes and levels were defined on the basis of an expert interview, market analysis and literature review (**Table 3**). Thereby, the attribute levels were located in terms of the percentage of bioplastic in fabric in the market for rain jackets in 2016 (20%) or assumed that higher percentages of bioplastics might potentially be of importance to consumers (50, 100%). The biogenic resources shown in the CBC contain substances/compounds that can be used to manufacture bioplastics for textile usage. Sanad (2016) found that the origin of the apparel is of relevance to consumers. The attribute levels in terms of origin of resource were selected in accordance with the potential location of crop cultivation. According to Borin et al. (2011) and Chekima et al. (2016) eco-labels or certificates are of value to consumers in that they serve to create product trust, communicate certain properties of a product, and promoting the purchase of green products. Therefore, three certificate types familiar from the German market were included in the CBC design. The prices chosen for the CBC display a wide range of 69€ to 349€. However, this price range is realistic for the German market for functional rain jackets for outdoor usage. Respondents were also able to select the option "None", see **Appendices**. This is interpreted as the choice threshold, as it means that the respondents preferred none of the three product concepts listed. The "None" option formed part of every choice set and represented the influence on utility of not choosing a product.

Relevant Factors Influencing Consumers' Price Preferences for Bio-Based Products

The relevant factors were determined by way of an extensive literature review, as presented in section Factors Influencing Consumers' Price Preferences With Bio-Based Apparel. The factors were measured with validated scales used in previous studies, reformulated as necessary for the purpose of this study (**Table 4**).

TABLE 1 | Overview of analysis of influencing factors on consumers' price preferences for purchasing green products.

References	Socio-demographic variables (age, gender, education)	Altruism	Subjective norm of bio-based apparel	Innovativeness	Green consumer values	Attitudes toward bioplastics	Product experience with bio-based products	Interest in bioplastics	Purchase intention
Blesin et al. (2017)							x		
Casimir and Dutilh (2003)	x								
Diamantopoulos et al. (2003)	x								
Englis and Phillips (2013)				x					
Hartmann and Apaolaza-Ibáñez (2012)						x			x
Haws et al. (2014)					x				
Hefner (2013)		x	x						
Hess et al. (2013)	x								
Jansson (2011)				x					
Klein et al. (2019)	x		x			x	x	x	
Klein et al. (2020)				x			x		
Kurka (2012)					x				
Laroche et al. (2001)									x
Lee et al. (1995)							x		
Lusk et al. (2007)		x							
McDonald et al. (2009)								x	
Mishra et al. (2014)			x						
Morrison (1979)									x
Nam et al. (2017)			x						x
Niedermeier et al. (2021)					x				
Niedermeier et al. (2021)	x				x				
Osburg et al. (2016)				x					
Pfattheicher et al. (2016)		x							
Rumm et al. (2013)						x		x	
Rumm (2016)						x			
Scherer et al. (2017)				x	x	x			
Schleenbecker and Hamm (2013)								x	
Straughan and Roberts (1999)	x	x							
Stern et al. (1993)		x							
Tanner and Wölfing Kast (2003)	x								
Tarkiainen and Sundqvist (2005)			x						
Tellis et al. (2009)				x					
Teng et al. (2015)		x	x			x			
Untaru et al. (2016)			x						
Young (2000)							x		
Young et al. (2009)							x		
This study	x	x	x	x	x	x	x	x	x

TABLE 2 | Sociodemographic data of the sample.

Variable	Sample	Population of Germany 16+ German Federal Statistical Office, 2015
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

The same sample was used in the studies of Klein et al. (2019, 2020) but with different study objectives and methods.

TABLE 3 | Attributes and levels of the choice-based conjoint analysis.

Attributes	Levels
Percentage of bioplastic in fabric	100%
	50%
	20%
Biogenic resource	Potatoes
	Woodchip
	Sugar cane
	Maize
Origin of resource	South America
	European Union
	United States of America
	Asia
Product certificate	Free of pollutants
	Climate protection
	Fair production
	No certificate
Price	349€
	239€
	109€
	69€

The CBC setting was also used in the study of Klein et al. (2020) but with different study objectives and analyzing methods.

Segmentation of Consumers Using Latent Class Analysis

Segment-specific parameters are estimated in the latent class model. This allows heterogeneous reactions of respondents to explanatory variables, such as price to be modeled (Temme, 2009). This results in the following utility function for each $k = 1, \ldots, M$ segment (2):

$$U_{ikn} = X_{in}\beta_k + e_{ikn} \quad (2)$$

By integrating the extreme value distributed disturbance term, the conditional selection probability for each segment k is obtained (3) (Temme, 2009).

$$P_n(i|k) = \frac{e^{V_{kin}}}{\sum_i e^{V_{kjn}}} \quad (3)$$

A latent class analysis based on a maximum likelihood estimation was performed with Sawtooth 8 to calculate clusters within the sample for the purpose of dividing consumers into heterogeneous classes based on their preferences for certain product attributes (Sawtooth Software Inc., 2004). At the beginning of the estimation process, the utility values for each segment were determined randomly. Afterwards, the data from each respondent was compared with the utility values of each segment and the probabilities of each respondent belonging to each segment calculated, while utility values and group affiliations were iteratively improved. The clustering was estimated with different group solutions. The best group solution was chosen by an appropriate Consistent Akaike Information Criterion (CAIC) and an appropriate relative Chi-square. Group size and coherence were also considered (Sawtooth Software Inc., 2004).

Classification Through Discriminant Analysis

Discriminant analysis is a method of classifying a dependent variable by the independent variables; it enables the study of two or more groups (Backhaus et al., 2000). The discriminant function Y gives information about the optimal separation between the groups and allows to test the discriminatory significance (discriminant coefficients of the feature variables b_j) of the feature variable X_J (4).

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots + b_JX_J \quad (4)$$

In this study, the variables were identified that distinguished respondents who either indicated high part-worth utility values for low prices, respectively moderate prices for bio-based apparel. Respondents were divided into two group clusters based on the results of the latent class analysis. All six groups of latent-class analysis were thus scrutinized to determine values of relative importance and values of part-worth utilities within the latent-class analysis,. It was found that the latent class analysis segments A, D, E, and F all had the highest significance with regard to the importance of price, and the utility values within the price

TABLE 4 | Constructs of the survey.

Variable/item	Statements	Possible answers	Cronbach's Alpha	Sources
Gender	Please choose one of the following answers.	1 = Female; 2 = Male	–	Reformulated according to (Rumm, 2016)
Age	In what year were you born?	Metric input of the year of birth, open field	–	Reformulated according to (Rumm, 2016)
Education	What is your highest level of education?	1 = No general education (as yet); 2 = Secondary school without apprenticeship; 3 = Secondary school with apprenticeship; 4 = General certificate of secondary education; 5 = General qualification for University entrance 6 = Studies (University, or other institute of higher education)	–	Reformulated according to (Rumm, 2016)
Altruism	How important is to you: To help other people To serve mankind To share what you have To give to others 5. To be unselfish	1 = Not important at all; 2 = Not so important; 3 = Sometimes important; 4 = Quite important; 5 = Important in all cases	0.845	Price et al., 2018
Subjective norm for bio-based apparel	How much would people close to you (e.g., partner, children, parents, friends) expect you to buy a rain jacket / other functional apparel made from bioplastics rather than petroleum-based plastic?	1 = Definitely would not; 2 = Unlikely to; 3 = Maybe; 4 = Probably; 5 = Certainly	–	Reformulated according to (Rumm, 2016)
Innovativeness	Please indicate to what extent you agree with the following statements. 1. I hate any change in my routines and habits. 2. New products have an unacceptably high price. 3. I am excited to try out new products. 4. I enjoy the novelty of owning new products. 5. I like to be confronted with new ideas. 6. Products are getting shoddier and shoddier.	1 = I don't agree at all; 2 = I generally don't agree; 3 = I agree in part; 4 = I would tend to agree; 5 = I totally agree	0.626	Tellis et al., 2009; Scherer et al., 2017
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.	1 = I don't agree at all; 2 = I generally don't agree; 3 = I agree in part 4 = I would tend to agree; 5 = I totally agree	0.895	Haws et al., 2014
Attitude toward bioplastics	Below are a number of statements from various organizations about bioplastics. Please state for each statement whether you would persuade or dissuade them from supporting the increased use of bioplastics. If the statement is of little or no relevance to you, please select "I don't really 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 purchase of bioplastic products helps to conserve fossil resources (petroleum). 3. My purchasing habits are affected by my concern for our environment. 4. I am concerned about wastage of resources on our planet.	1 = I don't agree at all; 2 = I generally don't agree; 3 = I don't really care; 4 = I would tend to agree; 5 = I totally agree	0.782	Reformulated according to (Rumm, 2016)

(Continued)

TABLE 4 | Continued

Variable/item	Statements	Possible answers	Cronbach's Alpha	Sources
	5. I would describe myself as environmentally responsible. 6. I am willing to accept inconvenience in order to take actions that are more environmentally friendly.			
Product experience with bioplastics	Have you ever deliberately opted for bioplastics in products?	0 = No; 1 = Yes	–	Reformulated according (Rumm, 2016; Scherer et al., 2018b)
Interest in bioplastics	Overall, are you interested in bioplastics in general?	1 = I am not interested at all; 2 = I am not so interested; 3 = I could be interested; 4 = I am a little interested; 5 = I am very interested	–	Reformulated according to (Rumm, 2016)
Purchase intention for bio-based products	How will you decide in future purchase situations? 1. I will consciously pay attention to bioplastic products made of renewable resources in future purchase decisions. 2. When I have the choice between a plastic product made of conventional materials and one made of renewable raw materials in the future, I will choose the one made of renewable raw materials.	1 = Definitely not; 2 = Not really; 3 = Maybe; 4 = Probably; 5 = Certainly	0.816	Buxel, 2010; Rumm, 2016

Some of the variables were also used in the studies of Klein et al. (2019, 2020) but with different study objectives and methods.

attribute-levels had the highest values for the lowest price level. Groups B and C neither showed their highest importance for the price, nor did they show the highest utilities at the lowest price level but for the moderate price level (see **Table 5**). Therefore, two aggregated consumer groups were formed separating those consumers showing clear preferences for a low price of a bio-based product and those showing acceptance of a moderate price for such products. Finally, a discriminant analysis was used to investigate those factors that were able to distinguish between these two groups.

RESULTS

The results of the different statistical analysis steps are shown in the following two paragraphs.

Consumer Segmentation Using Latent Class Analysis

A latent class analysis of the CBC experiment data was used to for consumer segmentation that was performed in two to ten groups. The six-group solution was chosen because it had a comparatively well-fitting CAIC value (24,975.22) and related chi-squared value (138.22). **Table 5** shows the average importance of each attribute together with the part-worth utilities of the attribute levels for the identified six consumer clusters. Cluster A aggregates respondents for whom price is of high importance. The "None" option displays a high negative part-worth utility, which strongly indicates that respondents of this cluster would rather choose functional clothes made of bioplastic, although other attributes apart from price revealed relatively low importance values. Cluster B aggregates respondents attributing moderate importance to price and relatively high importance to the origin of the biogenic resource. This cluster has the highest part-worth utility for a price of 109€, with woodchip produced in the EU as the preferable biomass. Respondents of cluster C show a higher preference for certified functional bioplastic apparel and a moderate importance assigned to price as well. They also display the highest utility for a price of 109€ and express a strongly negative part-worth utility for the "None" option. The clusters D, E, and F all indicate a high price importance, and all show a strong preference for the lowest price of the rain jacket as well as positive part-worth utilities for the "None" option. Smaller differences can be found between clusters D, E and F, particularly in relation to the evaluation of the plant origin or the location of production of the biogenic resource.

Influence of Independent Variables on Group Segmentation

Preferences for bio-based apparel were investigated by the CBC, and respondents were segmented through a latent class analysis. A preference for low-price products was apparent in the clusters A, D, E, and F, while in the two clusters B and C, respondents indicated lower utilities for the lowest price and preferred the price of 109€ for the rain jacket (**Table 6**). The respective clusters were aggregated for further analysis into two classes, with a distinction made between the groups indicating a "preference for a low price" and "acceptance of a moderate price." A discriminant analysis was conducted to determine the influence of different influencing factors on price preferences in these two groups. The test parameters of the discriminant function analysis reveal low separation by the variables, as indicated by a Wilks' Lambda of 0.919. Still, the groups can be separated with a probability of

TABLE 5 | Clusters of the latent class analysis.

Cluster	A	B	C	D	E	F
Cluster size	18.1%	11.4%	27.7%	21.5%	14.0%	7.4%
PART WORTH UTILITIES RESCALED FOR COMPARABILITY						
Percentage of bioplastic in the fabric						
100%	26.9	18.4	61.3	42.6	34.2	−1.7
50%	4.5	2.4	−2.9	1.2	−24.7	5.1
20%	−31.4	−20.8	−58.4	−43.8	−9.5	−3.4
Biogenic resource						
Potatoes	5.2	−12.8	−1.3	−8.1	13.4	−4.2
Woodchip	−1.7	49.2	−2.9	3.2	−3.6	0.1
Sugar cane	−2.5	−29.0	8.5	6.6	22.5	−2.2
Maize	−0.9	−7.4	−4.2	−1.8	−32.3	6.2
Origin of biogenic resource						
South America	−0.9	−25.7	−17.1	−11.2	−23.8	−6.5
EU	18.6	111.2	58.1	26.1	72.8	4.2
USA	−6.2	−16.3	−6.0	−5.4	−11.3	−1.0
Asia	−11.5	−69.2	−35.1	−9.6	−37.6	3.3
Certificates						
Free of pollutants	4.8	11.9	45.0	26.9	30.5	−0.1
Climate protection	13.3	25.5	25.1	24.3	11.4	3.8
Fair production	15.9	14.7	43.6	19.4	−6.4	8.1
No certificate	−34.1	−52.1	−113.7	−70.5	−35.6	−11.8
Price						
349€	−190.2	−74.1	−68.3	−149.0	−98.1	−277.2
239€	−70.4	−1.0	4.0	−53.6	−74.9	15.9
109€	97.0	50.7	47.4	87.5	61.2	88.1
69€	163.6	24.3	16.9	115.2	111.8	173.2
None option						
None option	−98.9	93.8	−262.9	93.8	283.8	118.0
ATTRIBUTE IMPORTANCE IN %						
Percentage of bioplastic in the fabric	11.7	7.8	24.0	17.3	11.8	1.7
Biogenic resource	1.5	15.6	2.5	2.9	11.0	2.1
Origin of biogenic resource	6.0	36.1	18.6	7.5	22.1	2.1
Certificate	10.0	15.5	31.7	19.5	13.2	4.0
Price	70.8	25.0	23.1	52.8	42.0	90.1

TABLE 6 | Structure matrix of discriminant analysis.

Independent variables	Wilks-Lambda	*F*	Significance	Function
Purchase intention for bio-based products	0.948	90.768	0.000*	0.787
Green consumer values	0.964	61.517	0.000*	0.648
Subjective norms of bio-based apparel	0.966	59.374	0.000*	0.637
Innovativeness	0.974	43.936	0.000*	0.548
Altruism	0.975	43.425	0.000*	0.544
Product experience	0.980	33.642	0.000*	0.479
Attitude toward bioplastics	0.992	13.571	0.000*	0.404
Interest in bioplastics	0.986	23.888	0.000*	0.304
Age	0.999	2.069	0.151	0.119
Gender	0.999	2.043	0.153	0.118
Education	1.000	0.700	0.403	0.069

**Significant at 99.9% level ($p < 0.001$).*

error of 0.0001, checked by the chi-square test that is highly significant. The structure matrix shown in **Table 6** describes the contribution of the independent variables to the separation of the two groups, starting with the variable with the strongest group-separating effect, as well as their significance in the separability of the two groups. The sociodemographic variables show no significant contribution to the discrimination, whereas all other variables are significant to the differentiation between the two price preference groups. Related to the strength of the separation effect, the purchase intention for bio-based apparel is the strongest separating variable, followed by GCV and subjective norms of bio-based apparel, whereas interest in bioplastics, attitudes toward bioplastics and previous product experience reveals weaker but still statistically highly significant effects.

DISCUSSION AND CONCLUSIONS

Main Findings of the Study

The first target of this study was to identify different consumer segments with differing preferences for product pricing for bio-based apparel. On the one hand, two clusters of consumers were identified including 39% of respondents with acceptance of moderate prices for bio-based products. Scherer et al. (2018b) found similar effects, whereby the attributes "contains bio-based plastic" and "of vegetable oil origin" or "contains softeners" showed higher average importance values than the "price" attribute. Hustvedt and Bernard (2008) showed that participants in an experimental auction were willing to pay more for socks made of organic fibers, which can be regarded as a green attribute and is comparable to the "percentage of bioplastic in the fabric" attribute in this study. On the other hand, four clusters of consumers were discovered that have clear preferences for low prices of bio-based products. These consumers accounted for 61% of the respondents. Kurka (2012) found similar results, showing that participants who preferred non-bio-based plastics also preferred low prices.

Another aim of this study was to determine relevant influencing factors for the price preference of bio-based apparel. In this context the important separating variables were identified characterizing the two groups. The variables GCV, purchase intention for bio-based products, and subjective norm bio-based apparel were found to be the most suitable for separating the two groups into those with a "preference for a low price" and those showing "acceptance of a moderate price." In this context, Scherer et al. (2018b) conclude that GCV plays a major role in separating the classes of consumers who are interested in bio-based products from those who are not. Innovativeness, altruism, product experience with bio-based products and attitude toward bioplastic are variables with a comparatively moderate influence on distinguishing between the groups. Scherer et al. (2018b) also found that innovativeness had an influence on the separation of consumers into those interested and those not interested in bio-based products, although in the same study, no influence could be determined by product experience with bio-based products. Hustvedt and Dickson (2009) could not find that altruistic behavioral beliefs differed between two segments of organic cotton apparel consumers, but they did find an influence of environmental and apparel attitudes on separation of consumers. The high relevance of GCV for separating between different consumer types of bio-based products is also supported by Niedermeier et al. (2021). The same is true in case of subjective norms related to bio-based apparel in the study of Klein et al. (2019).

Interest in bioplastics reveals a comparatively low significant influence toward the separation of price preference classes. A general interest in bio-based products was also found in previous studies by Yue et al. (2010), Kurka (2012), Behe et al. (2013), and Kainz (2016). As in studies by Diamantopoulos et al. (2003), Tanner and Wölfing Kast (2003), Hess et al. (2013), Klein et al. (2019), and Niedermeier et al. (2021), this study has shown as well that socio-demographic characteristics have no relevance in the separation of the defined consumer groups.

Limitations of the Study

As with all empirical investigations, this study also has its weaknesses. A familiar weakness of surveys on environmental issues is that respondents' answers can be biased by social desirability (Grimm, 2010), and this cannot be ruled out here either. However, there are indications from Kaiser et al. (1999) and Milfont (2009) which suggest that the results of surveys are still representative, the aspect of social desirability notwithstanding.

Within the limited frame, budget and time of this study, it was not feasible to test all potential separation variables. It is therefore possible, that previously less prominent variables might have a greater influence than assumed. However, the selection was based on an extensive literature review, in which variables were found to be highly relevant for these purposes. In addition, such product attributes and levels were chosen within the CBC experiment that gave a realistic view of existing and emerging products that may possibly rise in importance in the future. Nevertheless, it is hardly possible to consider all product attributes in a CBC.

Furthermore, the number of levels may have an effect, as not all attributes had the same amount of levels within the CBC. This can cause a bias in the estimation of relative importance, whereas attributes with more levels could result in an artificially higher estimate (Eggers and Sattler, 2011). However, in this case, only the attribute "percentage of bioplastic in the fabric" was set with fewer levels. The consequence of this would be that all other attributes would be overestimated or the opposite "percentage of bioplastic in the fabric" would be underestimated. The level of error that affects the relative importance of the price attribute can therefore be considered very low or non-existent.

This study was conducted in Germany and is representative of the population of this country. Other countries might have different socio-economic conditions, so it is important to carry out comparative studies and to check transferability to other societies. The same applies to transferability to apparel in general; this study concerned an outdoor rain jacket, and whether the same influencing factors also apply to other garments with environmental benefits needs to be investigated.

Although the discriminant analysis separation is validated as significant, Wilk's-Lambda shows a low discriminant function separation force. This may be due to the low separating force of

the independent variables vs. the dependent variable. However, it is much more likely that it is because consumers are not yet able to accurately assess the product and its attributes because they still lack experience with bio-based apparel. Only when consumers have formed precise preferences can this be reflected in their price preference. Until the market for bio-based apparel has undergone further development, future research will be needed to reveal more sensitive factors for the classification of price preference toward bio-based apparel or to further test and compare the factors used in this study.

Conclusions

This study contributes further insights toward the understanding of consumer decisions in the context of bio-based apparel. In addition to assessing the relevance of the attributes and influencing variables, the focus of this study was on the significance of price preference. Since products always have different attributes, it is important to understand the relevance of the products and the psychographic characteristics of consumers and, if necessary, to link them to a price perception. In this way, companies are also able to understand the economic relevance of various attributes. Furthermore, a CBC does not represent a study of real behavior. This could be considered in future studies and implemented in a field experiment or in the observation of real purchase behavior if enough bio-based products are available on the markets of apparel.

This study supports the development of new green apparel based on consumer preferences (e.g., with respect to type and content of fiber, origin of the biomass, certificates) and in particular, pricing of bio-based apparel. It shows that almost 40% of German consumers would make compromises with respect to the prices of bio-based apparel. However, it is highly relevant that the factors supporting assignment to price preference groups are also taken into account when marketing such products. These findings also relate to previous findings of Hustvedt and Bernard (2008) and Scherer et al. (2018b).

This research contributes to the development of sustainable supply chains for the production of green apparel. Supply chain managers in procurement, sales and production will benefit from the findings of this study. Similar to studies by (Imran et al., 2020; Jemai et al., 2020; Tayyab et al., 2020; Habib et al., 2021), it is possible to develop an importance classification for customers and suppliers in a supply chain for bio-based apparel.

Industries in the textile business and in the supply chains of textiles can use the insights of this study to define consumer groups interested in green or bio-based apparel as well as their motivations and behavior. The results of the CBC segmentation experiment supports product design of related apparel but also organizing the supply chains for the type of biomass used or the country of origin of the biomass raw material. Additionally, they show that interested consumer groups for green or bio-based apparel have high expectations with respect to labeling of such products that should not only be free of pollutants but also incorporate a climate protection as well as a fair trade and fair production label.

Only if the explicit expectations of interested consumers of green or bio-based apparel can be fulfilled by textile companies, such consumers will be willing to pay a price premium for such products. This can be supported by information and communications strategies for related products that are touching the main motivations of interested consumer groups, such as green consumer values, altruism or positive attitudes toward bioplastics products and additionally include the aspect of subjective norms (i.e., influence of persons who are close to the recipient) in the communication strategy. Since consumers are also motivated to consume bio-based products after having product experiences with them, companies wishing to introduce bio-based apparel to the market should aim at launching not just a single product, but at least a small range of such apparel. A broader range of bio-based apparel offered by a company will also increase opportunities of being listed in relevant retail chains selling such apparel. Overall, the study shows that there are market opportunities for green or bio-based apparel, including the possibility of getting higher prices paid by at least some consumers in Germany. Thus, the insights of this study support the textile industry to realize these business opportunities in the coming years.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because confidality reasons. Requests to access the datasets should be directed to Klaus Menrad, klaus.menrad@hswt.de.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FS: conceptualization, methodology, software, validation, formal analysis, investigation, writing—original draft, writing—review and editing, and visualization. AE-K: conceptualization. KM: conceptualization, writing—review and editing, supervision, project administration, and funding acquisition. All authors contributed to the article and approved the submitted version.

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APPENDICES

TABLE A1 | CBC introductory 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. The size, color, cut and function of the jacket meet your expectations. The seller points out that some jackets are made from bioplastics. He goes on to say that various renewable raw materials were used for its production instead of petroleum, 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 that there are also various certifications on the rain jackets, which give information on the production and material of functional apparel.

TABLE A2 | Choice set (example for random task).

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