Eco-friendly alternatives to food packed in plastics: German consumers' purchase intentions for different bio-based packaging strategies

ABSTRACT

Growing concern about the environmental consequences of plastic packaging has led to the development of strategies that discourage single-use fossil-based plastic packaging and promote sustainable bio-based alternatives. Nevertheless, it is unclear how different bio-based packaging strategies are perceived by consumers. Research suggests an ambivalent relationship regarding bioplastics and a positive perception of paper. In this study, we investigated how consumers' purchase intentions differ for two bio-based packaging alternatives—bioplastic and paper—in comparison to recyclable fossil-based plastic packaging for three products: fresh soft fruits, margarine/butter, and vegetable oil. Moreover, we explored the mediating roles of perceived eco-friendliness and perceived convenience and tested the moderation effect of green consumption values. In total, 2755 German consumers completed an online survey with a 3x3 between-subjects design in January 2022. The findings show that consumers' purchase intentions differed between different packaging types and products. The higher consumers perceived the eco-friendliness of the packaging, the higher their purchase intention. This effect was stronger for people with higher green consumption values. While paper-based food packaging was perceived as most eco-friendly, it was not always perceived as convenient, and may therefore lead to rejection. For fresh soft fruits, paper-based packaging appears to be the best solution for consumers. For vegetable oil, the bioplastic option received the highest purchase intention. Nevertheless, there are product categories—such as margarine/butter—where the benefits of bio-based packaging are not obvious to consumers and should therefore be communicated clearly.

Keywords: sustainable packaging; bio-based materials; food products; consumers' purchase intention

1. INTRODUCTION

Approximately 40% of global plastic demand is for packaging, but only 14% of plastic-based packaging is recycled. Enormous quantities end up in landfill or are incinerated (European Commission, 2018; Jambeck et al., 2015). Plastic packaging does not only consume finite fossil resources, but contributes to large amounts of waste that damage the marine environment and freshwater ecosystems (Jahnke et al., 2017; Law, 2017). Nevertheless, global demand for plastics is on the rise, and its production is expected to double over the next 20 years (European Commission, 2018).

To tackle this challenge, EU regulations and strategies have been developed to discourage single-use plastic and promote both recycled and renewable, bio-based materials (European Commission, 2018). Recycling of plastic is important, but especially when it comes to food products recycled packaging is often restricted due to concerns regarding health risks (EFSA, 2015). Renewable resources are needed to design eco-friendly bio-based food packaging. However, designing eco-friendly food packaging is a complex task since the packaging should preserve product quality and must satisfy environmental and marketing requirements (Mendes & Pedersen, 2021). Although there is currently no one-size-fits-all solution for a sustainable packaging strategy, the bio-based approach has recently gained much attention (Mendes & Pedersen, 2021; Shevchenko et al., 2022). The term 'bio-based' refers to products that are derived from renewable biological raw materials such as

corn or grass (BMBF, 2020; European Commission, 2017). Two bio-based alternatives are promoted: bioplastic- and paper-based packaging. These two alternatives provide different benefits in terms of eco-friendliness and convenience, which are important factors when consumers perceive compromises (Magnier et al., 2019; Steenis et al., 2017). It adds to the complexity of sustainable packaging development that eco-efficiency depends on the product category evaluated (Ifeu, 2021). Bioplastics are considered promising due to some shared characteristics with fossil-based plastics and possible advantages such as a reduced carbon footprint. However, much confusion surrounds bioplastics as they can—but do not have to—be biodegradable (European Bioplastics, 2020). Consequently, each bioplastic solution has to be evaluated separately (Spierling et al., 2018). The advantages of paper are its recyclability and biodegradability. Paper-based packaging for fresh soft fruits or vegetables is increasingly found in supermarkets. Current research activities focus on the development of innovative paper packaging. Many packaging companies such as, e.g., Papacks[1] or Paboco[2] work on fiber-based bottles for liquids.

However, in order to successfully market bio-based solutions, it is essential to gain insights into the drivers of consumers' purchase intentions for different eco-friendly food packaging alternatives. Only through a corresponding consumer demand for alternatives can the problem of dwindling resources and plastic waste and pollution be counteracted. Studies reveal that consumers infer perceived packaging sustainability (Herrmann et al., 2022; Liem et al., 2022) and also product quality (Magnier et al., 2016) from the packaging material. For organic fruits and vegetables in particular, evidence has been shown that unpacked goods are preferred to packaged goods (Herrmann et al., 2022; Van Herpen et al., 2016). Regarding recyclability, evidence exists that reusable packaging for online meal kits is perceived positively by consumers (Yoon et al., 2022). So far, communication of eco-friendly packaging attributes is limited (Dörnyei et al., 2022). Some studies exist that explore consumers' perceptions and purchase intentions for different sustainable packaging alternatives, particularly bioplastics (e.g., Herbes et al., 2018; Taufik et al., 2020; Wensing et al., 2020). Those studies conclude that bioplastics are mainly positively perceived by consumers due to their perceived eco-friendliness. A recent study that compared the perception of different plastic packaging solutions for juice bottles, i.e., recyclable, recycled, and compostable plastic (Testa et al., 2021), found that consumers could not appraise one solution as superior to others. Herrmann et al. (2022) even found a negative willingness to pay for grapes packed in bioplastic packaging.

Nevertheless, studies on paper-based packaging as an alternative as well as on consumers' purchase intention for different bio-based food packaging alternatives are scarce. Especially the comparison of different food product categories is lacking – yet highly recommended (Herrmann et al., 2022). Against this background, the present study contributes to the literature stream on consumers' perception of sustainable food packaging by answering two research questions: 1) How do consumers' purchase intentions vary between bio-based food packaging alternatives for different product categories? 2) What factors influence these purchase intentions? Using the theoretical foundation of the Total Food Quality Model (Grunert, 2005; Grunert et al., 1996), this study explores German consumers' acceptance of two bio-based alternatives—bioplastic and paper-based packaging—compared to recyclable plastic packaging. The TFQ Model is adjusted to packaging and extended by including the moderation variable green consumption values (Haws et al., 2014). Furthermore, the study adds to the literature because we specifically compare the purchase intention for three different food product categories that are common for daily use: fresh soft fruit, margarine/butter, and vegetable oil. The three product categories fresh soft fruits, margarine/butter and vegetable oil were specifically chosen due to their different demands on the packaging's functional characteristics.

[1] https://www.papacks.com/en/circular-economy/

[2] https://www.paboco.com/

2. RESEARCH BACKGROUND

2.1 The influence of quality perception on purchase intention for bio-based (food) packaging

Exploring the role of perceived quality cues on purchase intention has been the subject of extensive research in the field of consumer behavior. Building on the vertical dimension of the Total Food Quality (TFQ) Model (Grunert, 2005; Grunert et al., 1996) and the quality perception process (Steenkamp, 1990), we take a closer look at the role of perceptions in elucidating differences in **purchase intention**. In this study, we particularly focus on the influence of the type of packaging, i.e., an extrinsic quality cue, on the purchase intention. Based on the extrinsic quality cues provided, consumers form their expected quality and indicate a purchase intention for a certain product mediated by perceived extrinsic quality cues. According to the TFQ Model, extrinsic quality cues lead to perceived extrinsic quality cues, which, in turn, lead to an to intention to buy. This model considers four dimensions of expected quality, namely taste, health, convenience, and process. For our study, we specifically focus on **convenience,** which is identified as a relevant dimension in the model. Additionally, the difference between the packaging types used in our study, is the production process of the product involving the use of bio-based material. Therefore, the process dimension of perceived quality is adjusted to the **eco-friendliness** of the packaging. While the relevance of perceived eco-friendliness of the packaging in explaining purchase intention or willingness to pay has been found for different product categories such as grapes (Herrmann et al., 2022), perceived convenience has been highlighted as important factor but has not been researched so far. Accordingly, we chose these two factors to explain the differences in purchase intention, i.e. the mediation effects. We expect the two mediators **perceived eco-friendliness** and **perceived convenience** to be independent and to explain different parts of consumers' purchase intention. Additionally, personal and contextual factors, such as values, are suggested as potential moderators with respect to quality perceptions (Steenkamp, 1990). Here, consumers' **green consumption values** are chosen (Haws et al., 2014).

2.2 Purchase intention for bio-based (food) packaging

Most studies focus on bio-based plastic packaging in general (Dilkes-Hoffman et al., 2019; Herbes et al., 2018; Mehta et al., 2021) or specific bio-based plastic types such as plastic bottles (Lynch et al., 2017; Onwezen et al., 2017; Testa et al., 2021; Zwicker et al., 2021), bio-based shopping bags (Lynch et al., 2017; Sijtsema et al., 2016), or packaging for blueberries (Almenar et al., 2010), sweet cherries (Koutsimanis et al., 2012), and tomatoes (Wensing et al., 2020). Although research suggests that consumers are more hesitant with bio-based plastic packaging for food versus non-food products (Mehta et al., 2021), studies mainly confirmed a positive perception and a higher willingness to pay (WTP) for bio-based plastic compared to conventional fossil-based packaging (e.g., Zwicker et al., 2021). Wensing et al. (2020) conducted a choice experiment with cherry tomatoes and tested the effect of different nudging strategies on consumers' WTP. The authors found the highest WTP when the strategy matched consumers' cognitive styles. Nevertheless, the concept "bio-based" can also be (partly) negatively perceived, e.g., as green-washing, which indicates that there is a certain ambivalence in the perception of these products (Lynch et al., 2017; Sijtsema et al., 2016). Other studies compared different packaging types or packaging characteristics according to their sustainability perception (Dilkes-Hoffman et al., 2019; Steenis et al., 2017; Taufik et al., 2020), quality (Olesen & Giacalone, 2018), or purchase intention or WTP (Koenig-Lewis et al., 2022; Testa et al., 2021; Zwicker et al., 2023). Comparing Italian consumers' purchase intention for different plastic packaging solutions for juice bottles, i.e., recyclable, recycled, and compostable bioplastic bottles (Testa et al., 2021), no differences in consumers' purchase intention were found. A recent study carried out with British consumers investigated the hypothetical choice of different bio-based water bottles based on Polyethylene Furanoate (PEF) (Zwicker et al., 2023). Findings show that consumers were significantly willing to pay higher prices for bio-based bottles — especially for the bottle that consisted of paper

PEF — compared to the conventional fossil-based water bottle. Compostable bio-based —here the packaging consisted of compostable bio-plastic and paper—and recyclable plastic food packaging were compared in a study by Koenig-Lewis et al. (2022) conducted in the UK using the examples of ready-to-eat cake, sandwich and salad boxes. The authors concluded that the compostable packaging option was perceived more positively and as healthier over all product categories, and that these categories influenced consumers' purchase intention. Hence, the following hypothesis is formulated:

H1: *Purchase intention is higher for bio-based alternatives compared to recyclable plastic packaging.*

2.3 Perceived eco-friendliness

Determinants such as the perceived eco-friendliness of bio-based packaging were mentioned as important purchase criteria in Dutch focus groups (Lynch et al., 2017; Sijtsema et al., 2016). A few studies have explored how consumers evaluate different packaging types, such as plastic, paper, and glass, with regard to its eco-friendliness. Compared to other materials, plastic packaging was perceived as least eco-friendly in a consumer study about packaged instant noodles in Vietnam (Nguyen et al., 2020) in a German study on packages for grapes (Herrmann et al., 2022) and also in an European report on consumers' packaging preferences (Tame, 2020).

Both paper as well as biodegradable materials in general are perceived as eco-friendly. While paper was rated highest (Dilkes-Hoffman et al., 2019; Herbes et al., 2018), no significant differences in consumers' perceptions of its eco-friendliness were found in an Australian study (Dilkes-Hoffman et al., 2019). Its recyclability and biodegradability particularly contribute to paper's eco-friendly image (Nguyen et al., 2020; Tame, 2020). Glass was also often perceived as environmentally sustainable (Boesen et al., 2019; Herbes et al., 2018; Tame, 2020), particularly due to its reusability and protection of the product (Tame, 2020).

Some studies compared consumers' sustainability evaluations with results from life cycle assessment (LCA) analyses (e.g., Boesen et al., 2019; Steenis et al., 2017). A Danish study by Boesen et al. (2019) explored consumers' evaluations of different liquid food categories (beer, milk, soft drink, olive oil, and skinned tomatoes). The authors revealed that beer bottles from wood fibers were perceived as most sustainable, while plastic alternatives were rated the lowest, although LCA analyses show that plastic alternatives are in fact not always the least eco-friendly option (Boesen et al., 2019).

Perceived eco-friendliness was recently explored as a relevant factor for the purchase intention for sustainable packaging by Testa et al. (2021). The authors found that consumers' purchase intention for bottled juice increases when the packaging is perceived as highly eco-friendly. A higher willingness to pay for grapes was also found for paper-based compared to plastic and bioplastic packaging due its perceived sustainability by Herrmann et al. (2022).

In line with former research, we propose the following hypotheses:

H2a: *Bio-based packaging alternatives are perceived as more eco-friendly than recyclable plastic packaging.*

H2b: *The influence of packaging type on purchase intention is mediated by perceived eco-friendliness.*

2.4 Perceived convenience

Perceived functional benefits play a key role in explaining consumers' perception of plastic packaging (see review by Heidbreder et al. (2019)). Many consumers perceive the protective performance of plastic

packaging as an advantage over paper-based alternatives (Nguyen et al., 2020). Consequently, some consumers stated that they prefer plastic packaging because it provides them with more convenience, ease of use, and hygiene. In particular the COVID-19 pandemic has contributed to consumers' increased food-safety concerns (Kitz et al., 2022). When functional features such as packaging safety, ease of use or portability are very important for a consumer, the packaging that is not perceived as providing this functional feature sufficiently might not be chosen (Boz et al., 2020; Van Birgelen et al., 2009).

While many studies focus on the effect of environmental friendliness on purchase behavior, packaging characteristics such as convenience are highlighted as potentially important determinants (Herbes et al., 2018; Herrmann et al., 2022), but literature on the effects of such characteristics on purchase behavior is scarce. Dilkes-Hoffman et al. (2019) found that the packaging's usefulness and convenience were rated lower for biodegradable plastic compared to regular plastic packaging. Monnot et al. (2015) explored the mediating role of perceived convenience for the case of overpackaging, using the example of yoghurt in France. The authors hypothesized that eliminating overpackaging reduces perceived convenience, and concluded that perceived convenience indeed mediates the relationship between eliminating overpackaging and purchase intention for the case of yoghurt.

H3: *The influence of packaging type on purchase intention is mediated by perceived convenience.*

Depending on the product category in question, the importance of functional characteristics of the packaging can vary (Jinkarn & Suwannaporn, 2015; Koutsimanis et al., 2012). For example, whereas fruits possess a shorter minimum shelf life compared to cooking oil and margarine/butter, food safety plays a major role for fruit and vegetable consumption (Nago et al., 2012). The consumption of dairy products on the other hand, is characterized by the need for refrigeration. For refrigerated products, evidence exists that the ease of storage and handling plays a major role (Van der Merwe et al., 2013). For cooking oil, in turn, the protection against sunlight is crucial to ensure the sensory properties (Loganathan et al., 2022). Therefore, the effect of functionality or convenience can be different depending on the food category. We did not specifically develop hypotheses regarding the differences between the three chosen product categories – this analysis is rather exploratory.

2.5 Moderating role of green consumption values

Compared to the widely known but broadly defined concept of environmental orientation or concern (Dunlap & van Liere, 1978), the concept of green consumption values (GCV) was specifically developed by Haws et al. (2014) for the consumption context. The authors' objective was to "develop a method to understand differences across consumers who do and do not value conserving the environment as part of their consumption behavior" (Haws et al. (2014, p. 337). Green consumption values are defined as "the tendency to express the value of environmental protection through one's purchases and consumption behaviors" (Haws et al., 2014, p. 337). The authors suggested a relationship between GCV and consumers' purchase intention for a green product.

This concept has been widely applied in different research fields. Regarding bioplastics, GCVs were identified as influencing factors on purchase intention for bioplastics in general (Klein et al., 2019), and for specific products such as sports equipment (Scherer et al., 2018), bio-based rain jackets (Klein et al., 2020) or bio-based glue sticks (Niedermeier et al., 2021). In the context of sustainable packaging, related concepts such as plastic-related behavior and concern about plastic pollution were identified as predictors for purchase intention (Testa et al., 2021). We assume a moderating role of GCVs and test the following hypotheses:

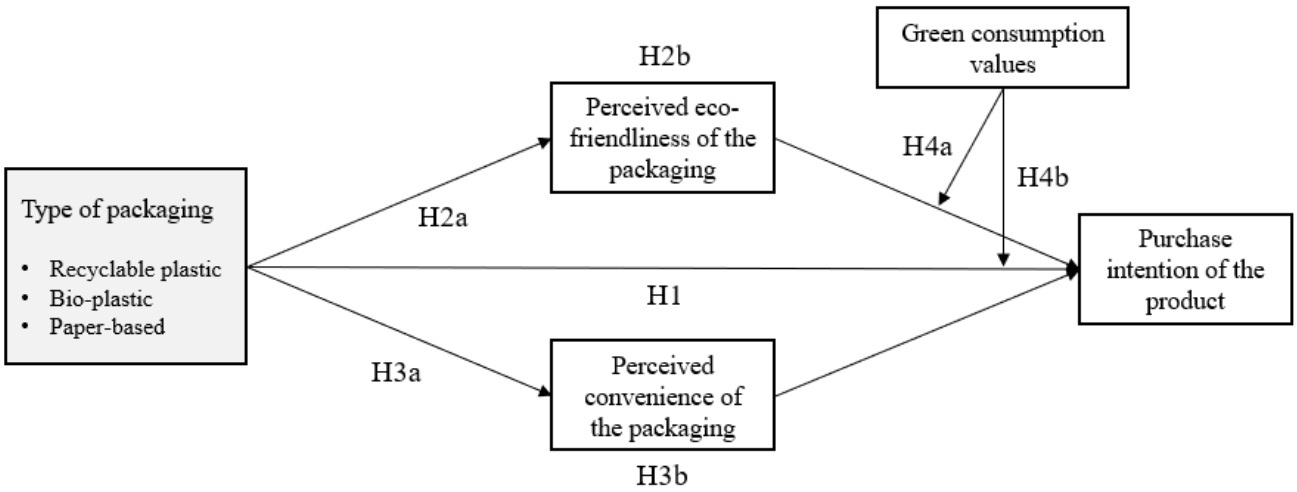
H4a: *Consumers' green consumption values positively influence the effect of perceived eco-friendliness on purchase intention.*

H4b: **Consumers' green consumption values positively influence the effect of packaging type on purchase intention*2.6 Conceptual model***

Deriving those hypotheses based on literature and the TFQ Model, helps to answer our two research questions. The first question focuses on whether the purchase intention for the two bio-based packaging types differ compared to recyclable plastic for the three product categories. The second question analyses the factors that explain differences in consumers' purchase intention. Following these two research questions and deriving the hypotheses, we determined our conceptual model (Figure 1).

Perceived eco-friendliness and *perceived convenience* function as mediators that explain the "how", i.e. the effect of the packaging type on people's purchase intention. Furthermore, the "when" is considered as we hypothesize that people's *green consumption values* moderate the relationships between packaging type and purchase intention and between perceived eco-friendliness and purchase intention.

Figure 1: Conceptual model.



3. METHODOLOGY

3.1 Research approach

3025 German participants recruited by a market research agency completed the survey in January 2022. Quotas for gender, age, and education were set based on the distribution of the German population. Participants were at least partly responsible for their household food shopping and had bought the respective food products in the previous three months. First, 270 participants were recruited for the pilot study to check for understandability of the questionnaire. Small adjustments were made afterwards. Finally, 2755 participants completed the main study. We used a 3x3 between-subjects design to group the participants randomly into nine groups (Table 1). To determine our required minimal sample size, we conducted an a priori power analysis with G*Power 3.1. (Faul et al., 2009). 882 participants are needed per product category to detect a small effect size of

f=0.12 with a power of 1-β= 0.90 and α= 0.05. Hence, we decided to sample approximately 300 participants per group based on the factors *packaging type* and *product category*.

Table 1. Group composition.

Factor	G1	G2	G3	G4	G5	G6	G7	G8	G9
Packaging type	Recyclable Plastic	Bioplastic	Paper	Recyclable Plastic	Bioplastic	Paper	Recyclable Plastic	Bioplastic	Paper
Product category	Fresh soft fruits			Margarine/butter			Vegetable oil		

3.2 Questionnaire and measurement

The questionnaire was structured as follows. First, two screening questions were asked to ensure that the participants were at least partly responsible for their household food purchase and regularly bought this type of food product. After the socio-demographic questions, participants were asked about their associations with bio-based packaging and were subsequently introduced to one of the nine products. They received a picture with a short description[3]. Afterwards, the participants indicated their perceived eco-friendliness and convenience of the respective product before indicating their purchase intention. Subsequently, they were asked to answer questions about their green consumption values. Additionally, we asked participants to indicate three out of eleven characteristics they thought were most relevant for eco-friendly packaging (e.g., recyclability) and added some open-ended questions to further assess response quality.

All constructs' items were measured on a 7-point Likert scale. The dependent variable *purchase intention* was measured using three items according to Fishbein & Ajzen (2010). The mediator *perceived eco-friendliness* was measured using three items adapted from Testa et al. (2021). The mediator *perceived convenience* was based on Monnot et al. (2015) but slightly adjusted to our three packaging types. The six-item scale of the moderator *green consumption values* was originally developed to measure people's expression of environmental friendliness through their purchase of products (Haws et al., 2014) and was used in the context of food products here. The constructs, their corresponding items, and its source can be found at OSF.

3.3 Data analysis

The survey was implemented in Qualtrics and the data were analyzed using the statistical software IBM SPSS Statistics 27 and MPlus7. First, descriptive analyses were performed and Welch's analyses of variances (ANOVAs) with consecutive Games-Howell post-hoc tests were calculated to compare the different group means of the dependent variable and the two mediators. Second, a confirmative factor analysis (CFA) was calculated by Mplus7 to check for the validity of the scales used. Overall, the CFA yields a good fit (Fornell & Larcker, 1981; Lam, 2012). The detailed results can be found at OSF. Afterwards, regression models based on mean scores using mediation and conditional process analysis were calculated with the macro PROCESS (Hayes, 2018). Here, the independent variable *packaging type* was treated as a multicategory variable where *recyclable plastic* packaging was used as the reference category. Hence, two dummy variables were created: *paper-based* vs. *recyclable plastic* (D_1) and *bioplastic* vs. *recyclable plastic* (D_2). We used PROCESS model 4 for calculating the mediation analyses. As our model consists of two mediators and one moderator, we could not use a predefined model and, therefore, customized the PROCESS macro, as described by Hayes (2018), accordingly. 10,000 bootstrap samples for percentile bootstrap confidence intervals were calculated for each

[3] Our materials and data can be found at OSF via the following link.

analysis. For the conditional process analysis, the variables *green consumption values* and *perceived eco-friendliness* were first mean-centered to render interpretable coefficients. To probe the interaction effects, the widely-used pick-a-point-approach was used (Hayes, 2018).

4. RESULTS

4.1 Sample properties

The final sample consisted of 2729 participants as we excluded 26 participants who indicated in open questions that they did not like or did not buy the respective product. All nine sub-samples were comparable regarding their socio-demographics. Chi-square tests yielded no significant differences in gender distribution ($\chi^2(16)=10.93$, $p=0.81$), age distribution ($\chi^2(40)=51.46$, $p=0.11$), education ($\chi^2(48)=56.30$, $p=0.19$), and regional distribution ($\chi^2(16)=25.11$, $p=0.07$). The samples were also representative for Germany, as shown for the sub-samples distinguished by product type (Table 2).

Table 2. Socio-demographics of the three sub-samples.

Category & Levels	% of the sample			
	Soft fruits (N = 898)	**Margarine/ butter** (N = 901)	**Vegetable oil** (N = 930)	**Germany***
Gender				
Female	50.1	49.6	50.8	50.7
Male	49.8	50.3	49.0	49.3
Non-binary	0.10	0.10	0.20	
Age				
18 to 39 years	30.9	32.1	33.0	30.0
40 to 59 years	33.7	37.4	36.0	34.5
60 +	35.3	30.5	31.0	35.5
Education				
Lower vocational education	20.9	21.2	19.7	20.9
Middle vocational education	59.3	61.0	59.4	59.4
Higher vocational education	19.8	17.8	20.9	19.7

Note: *Sources of the figures for the German population: education (Destatis, 2019), gender (Destatis, 2020b), age (Destatis, 2020a)

4.2 Descriptive results

On average, participants expressed relatively high green consumption values (M=5.11, SD=1.26); 53.4% indicated somewhat to very high green consumptions values. Additionally, regarding eco-friendly packaging, it appeared that the end-of-life product characteristics *biodegradability* and *recyclability* of the packaging were the most important characteristics for consumers, followed by *consisting of renewable (bio-based) resources* and *produced from recycled material*.

4.2.1 Purchase intention

Welch's ANOVAs showed that participants' purchase intention for **fresh soft fruits**, $F(2, 590)=29.35$, $p<0.001$, was significantly higher for *paper-based* compared to *bioplastic* ($p<0.01$) and *recyclable plastic* ($p<0.001$) packaging. All means of the different packaging types per product category are shown in Table 3. No significant differences between the three packaging types for **margarine/butter** ($F(2, 598)=1.65$, $p>0.05$) were found. For **vegetable oil**, the purchase intention for *bioplastic* was significantly higher than the purchase intention for either *recyclable plastic* bottles or *paper-based* bottles ($p<0.01$). While the intention to purchase *paper-based* packaging was highest for **fresh soft fruits**, there was no significant different purchase intention for **margarine/butter**. However, the purchase intention for the *bioplastic* alternative was highest for **vegetable**

oil. Hence, we can reject our hypothesis (H1) that both bio-based alternatives always receive a higher purchase intention.

Table 3. Purchase intention for the different packaging types per product category.

Packaging type	Product type					
	Fresh Soft fruits (n = 898)		Margarine/butter (n = 901)		Vegetable oil (n = 930)	
	Mean	SE	Mean	SE	Mean	SE
Paper-based	5.61a	0.08	5.16a	0.09	4.56a	0.10
Bioplastic	5.20b	0.09	5.13a	0.09	4.98b	0.09
Recyclable plastic	4.67c	0.10	4.93a	0.10	4.52a	0.11

Note: For all variables with the same letter, the difference between the means is not statistically significant. If two variables have different letters, they are significantly different.

4.2.2 Perceived eco-friendliness and convenience of the three packaging types

Considering perceived *eco-friendliness*, we found statistically significant differences between *paper-based* packaging and *recyclable plastic* and between *bioplastic* and *recyclable plastic* packaging (p<0.001) for all product types. Hence, in line with our hypothesis (H2a), both bio-based packaging alternatives were significantly perceived as eco-friendlier than the *recyclable plastic* alternative. The means are depicted in Table 4.

Table 4. Perceived eco-friendliness of the different packaging types per product category.

Packaging type	Product type					
	Fresh Soft fruits (n = 898)		Margarine/butter (n = 901)		Vegetable oil (n = 930)	
	Mean	SE	Mean	SE	Mean	SE
Paper-based	5.74a	0.07	5.22a	0.08	5.30a	0.08
Bioplastic	5.00b	0.09	5.13a	0.08	4.98b	0.09
Recyclable plastic	3.85c	0.11	4.39b	0.10	4.03c	0.10

Note: For all variables with the same letter, the difference between the means is not statistically significant. If two variables have different letters, they are significantly different.

Regarding **fresh soft fruits** (F(2, 595)=3.86, p<0.05), the *paper-based* packaging (M=5.49) was perceived as significantly (p<0.05) more *convenient* than the *recyclable plastic* packaging (M=5.21), while the perception of *bioplastic* (M=5.44) did not differ significantly. Again, for **margarine/butter**, we did not find significant differences in *perceived convenience* between the three packaging types (F(2, 599)=1.41, p>0.05). As expected (H3a), for **vegetable oil** (F(2, 617)=5.46, p<0.01), the *paper-based* bottle (M=4.95) was significantly (p<0.01) rated as less convenient than the *recyclable plastic* bottle (M=5.30). Nevertheless, perceived convenience of the *bioplastic* bottle (M=5.18) did not significantly differ. All means are shown in Table 5.

Table 5. Perceived convenience of the different packaging types per product category.

Packaging type	Product type					
	Fresh Soft fruits (n = 898)		Margarine/butter (n = 901)		Vegetable oil (n = 930)	
	Mean	SE	Mean	SE	Mean	SE
Paper-based	5.49a	0.07	5.42a	0.08	4.95a	0.08
Bioplastic	5.44a,b	0.05	5.60a	0.07	5.18a,b	0.07

Recyclable plastic	5.21b	0.08	5.51a	0.07	5.30b	0.07

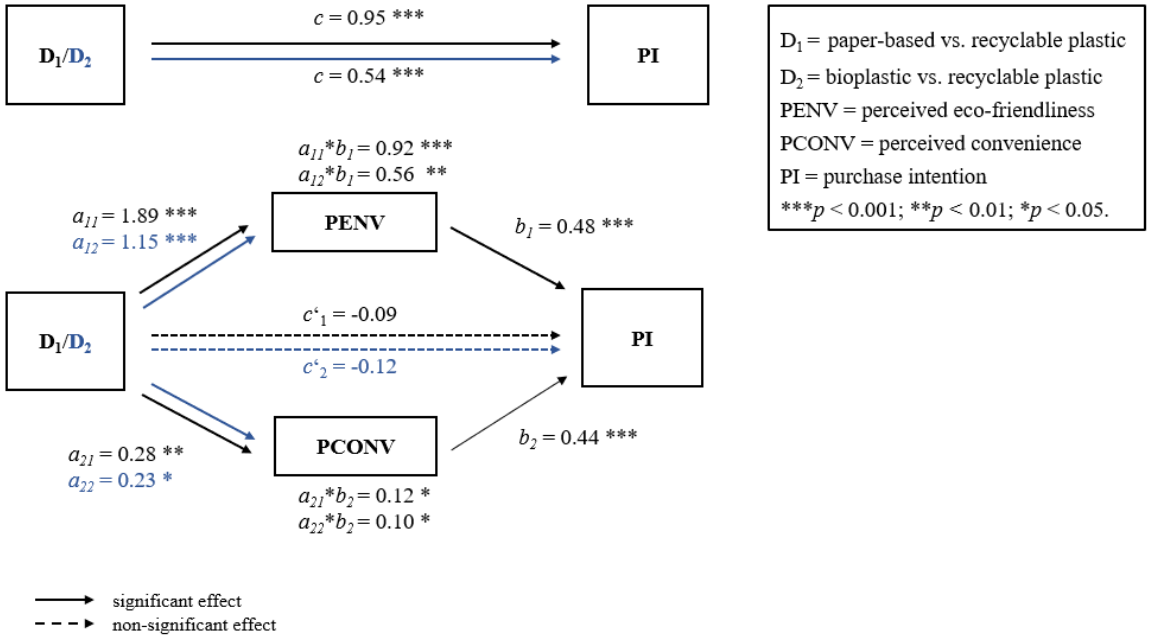
Note: For all variables with the same letter, the difference between the means is not statistically significant. If two variables have different letters, they are significantly different.

4.3 Mediation analyses

As assumed, the mediation analyses show that the effect of the packaging type on purchase intention is mediated by *perceived eco-friendliness* for all three product categories (H2b). We also found a mediation effect of *perceived convenience* (H3b). This mediation effect differed between the product categories and was not significant for **margarine/butter**. The corresponding tables can be found on OSF. A summary of the results for all hypotheses and their support is shown in Table 9 at the end of the results section.

Compared to recyclable plastic packaging, paper-based and bioplastic packaging were perceived as eco-friendlier (a_{11}=1.98; a_{12}=1.15) and also as more convenient (a_{21}=0.28; a_{22}=0.23) for **fresh soft fruits**. The more environmentally friendly (b_1=0.48) and convenient (b_2=0.44) the perception of the packaging, the higher the purchase intention indicated (Figure 2). Relative to recyclable plastic, paper-based packaging increased purchase intention by $a_{11}b_1$=0.92 as a result of the higher *perceived eco-friendliness* and by $a_{21}b_2$=0.12 as a result of a higher *perceived convenience*. Relative to recyclable plastic, bioplastic increased the purchase intention by $a_{12}b_1$=0.56 because of a higher *perceived eco-friendliness* and by $a_{22}b_2$=0.10 due to a higher *perceived convenience*. There was no evidence that purchase intention was influenced independently of the effects of perceived eco-friendliness and perceived convenience (c'_1=-0.09, p=0.33; c'_2=-0.12, p=0.17). The path denoted c = 0.95 represents the total effect which is the sum of all direct and indirect effects – in this case $c = a_{11}b_1$=0.92 + c'_1=-0.09 + $a_{21}b_2$=0.12 =0.95.

Figure 2: Mediation analysis for fresh soft fruits.

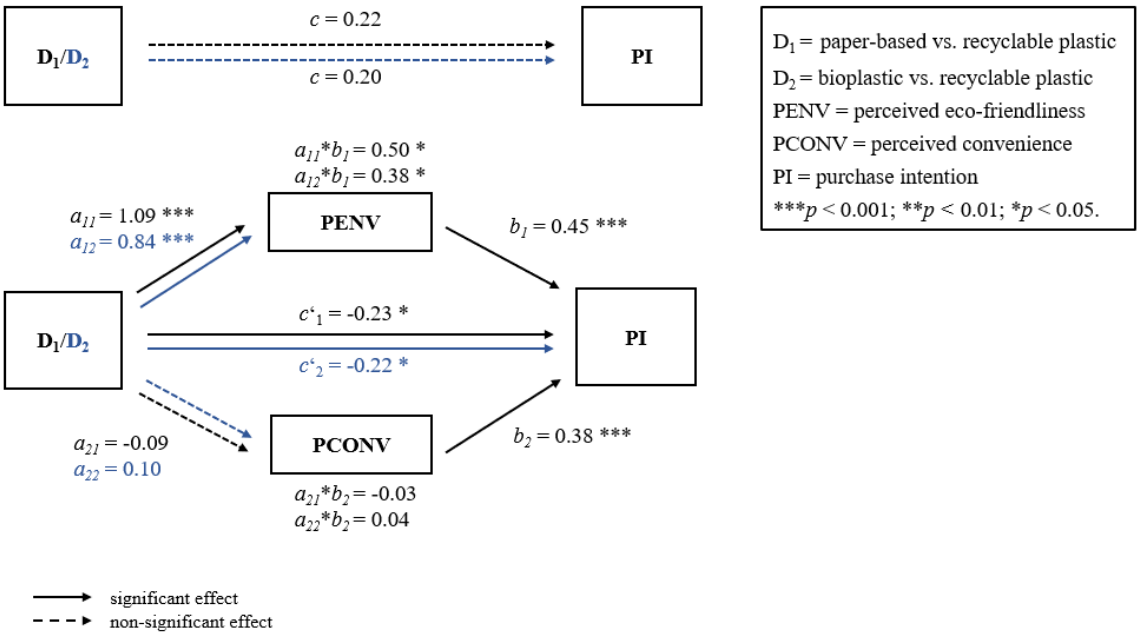


Regarding **margarine/butter**, both the paper-based and the bioplastic packaging were perceived as eco-friendlier (a_{11}=1.08; a_{12}=0.84) compared to the recyclable plastic packaging. However, compared to the recyclable plastic packaging, the two bio-based packaging alternatives did not lead to a significant higher or lower *perceived convenience* (a_{21}=-0.09; a_{22}=0.10). Nevertheless, the more environmentally friendly (b_1=0.45) and convenient (b_2=0.38) the perception of the packaging in general, the higher the purchase intention indicated.

Relative to recyclable plastic, paper-based packaging increased the purchase intention by $a_{11}b_1$=0.50 and bioplastic by $a_{12}b_1$=0.38 as a result of the higher *perceived eco-friendliness.* No mediation effect of perceived convenience was found (Figure 3). There is evidence that the purchase intention for **margarine/butter** was also influenced by the packaging type independently of the effects of perceived eco-friendliness and convenience, i.e., assuming no perceived differences in eco-friendliness or convenience between packaging types (c'_1=-0.23, p=0.03; c'_2=-0.22, p=0.04). Hence, consumers might have higher purchase intentions for margarine/butter in the recycled plastic packaging if they do not perceive differences in its eco-friendliness and convenience compared to the bio-based alternatives.

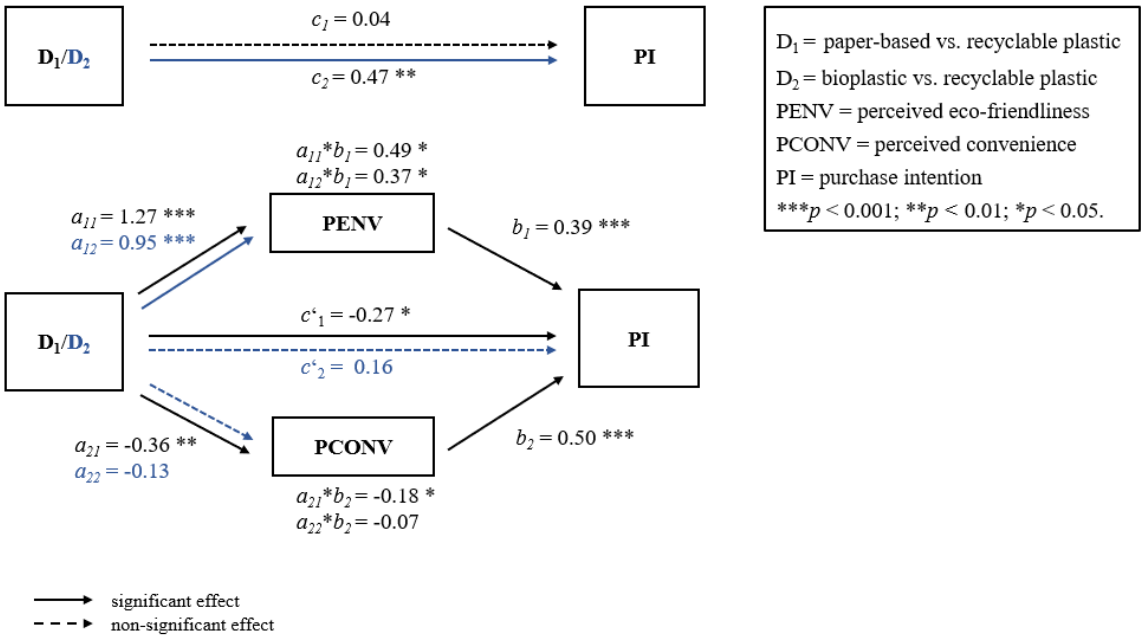
Regarding **vegetable oil** (Figure 4), again we found a mediation effect of perceived eco-friendliness. Similar to the other product categories, the more convenient (b_2=0.50) the perception of the packaging in general, the higher the purchase intention indicated. In contrast to soft fruits, we found that, compared to recyclable plastic, paper-based packaging decreased consumers' purchase intention by $a_{21}b_2$= -0.18 as a result of a lower *perceived convenience*. Again, there is evidence that the purchase intention was influenced by the packaging type independently of the effects of perceived eco-friendliness and perceived convenience (c'_1=-0.27, CI=[-0.50; -0.05]). If consumers do not perceive differences in the package's eco-friendliness and convenience, their purchase intention for the vegetable oil in a bio-based bottle might be lower compared to the recyclable plastic bottle.

Figure 3: Mediation analysis for margarine/butter.



Notes: Significance codes: ***p < 0.001, **p < 0.01, *p < 0.05

Figure 4: Mediation analysis for vegetable oil.



Notes: Significance codes: ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

4.4 Conditional process analysis

In a further analysis, we included the moderating variable *green consumption values (GCVs)* into our model as we assume that the mediating effect of perceived eco-friendliness and the direct effect of packaging type on purchase intention and is contingent on this moderator.

As assumed, the effect of **perceived eco-friendliness** (PENV) on purchase intention was moderated by consumers' *GCVs* for all three product categories (H5a) (soft fruits: b=0.06, p<0.001, CI=[0.03; 0.09] (Table 6); margarine/butter: b=0.07, p<0.001, CI=[0.04; 0.10] (Table 7); vegetable oil: b=0.07, p<0.01, CI=[0.03; 0.10]) (Table 8). Hence, the indirect effect of packaging type on purchase intention through perceived eco-friendliness increases with higher green consumption values.

Table 6. Results of the conditional process analysis for fresh soft fruits.

Antecedent	Consequent					
	M1 (PENV)		M2 (PCONV)		Y (PI)	
	b (SE)	*95% CI*	*b (SE)*	*95% CI*	*b (SE)*	*95% CI*
Constant	-1.02 (0.09) ***	[-1.19; -0.84]	5.21 (0.07) ***	[5.07; 5.35]	3.20 (0.18) ***	[2.84; 3.56]
D1	1.89 (0.13) ***	[1.64; 2.14]	0.28 (0.10) **	[0.08; 0.48]	-0.05 (0.09)	[-0.23; 0.13]
D2	1.15 (0.13) ***	[0.90; 1.40]	0.23 (0.10) *	[0.02; 0.43]	-0.11 (0.08)	[-0.28; 0.05]
GCV	-	-	-	-	0.10 (0.05) *	[0.00; 0.19]
D1*GCV	-	-	-	-	0.17 (0.07) *	[0.04; 0.31
D2*GCV	-	-	-	-	0.12 (0.07)	[-0.01; 0.25]
PENV*GCV	-	-	-	-	**0.06 (0.02) *** **	**[0.03; 0.09]**
PENV	-	-	-	-	0.46 (0.02) ***	[0.41; 0.51]
PCONV	-	-	-	-	0.37 (0.03) ***	[0.31; 0.43]
	R^2 = 0.20		R^2 = 0.01		R^2 = 0.61	
	$F(2, 895)=110.5$, $p<0.001$		$F(2, 895)=4.05$, $p<0.05$		$F(8, 889)=174.63$, $p<0.001$	

Note: D_1= paper-based vs. recyclable plastic; D_2= bioplastic vs. recyclable plastic; PENV= perceived eco-friendliness; PCONV= perceived convenience; PI= purchase intention; GCV= green consumption values; CI= Confidence interval; ***p<0.001; **p<0.01; *p<0.05.

Table 7. Results of the conditional process analysis for margarine/butter.

Antecedent	Consequent					
	M_1 (PENV)		M_2 (PCONV)		Y (PI)	
	b (SE)	*95% CI*	*b (SE)*	*95% CI*	*b (SE)*	*95% CI*
Constant	-0.65 (0.09) ***	[-0.82; -0.47]	5.51 (0.08) ***	[5.36; 5.66]	3.91 (0.21) ***	[3.49; 4.32]
D_1	1.08 (0.13) ***	[0.84; 1.33]	-0.09 (0.11)	[-0.29; 0.12]	-0.13 (0.09)	[-0.32; 0.05]
D_2	0.84 (0.13) ***	[0.59; 1.09]	0.10 (0.11) *	[-0.11; 0.30]	-0.10 (0.09)	[-0.28; 0.08]
GCV	-	-	-	-	0.30 (0.05) ***	[0.20; 0.40]
D_1*GCV	-	-	-	-	0.29 (0.07) ***	[0.16; 0.42
D_2*GCV	-	-	-	-	0.25 (0.07) ***	[0.11; 0.39]
PENV*GCV	-	-	-	-	**0.07 (0.02) *** **	**[0.04; 0.10]**
PENV	-	-	-	-	0.37 (0.03) ***	[0.31; 0.42]
PCONV	-	-	-	-	0.22 (0.04) ***	[0.40; 0.10]
	R^2 = 0.08		R^2 = 0.00		R^2 = 0.55	
	F(2, 898)=40.89, p<0.001		F(2, 898)=1.45, p=0.24		F(8, 892)=136.42, p<0.001	

Note: D_1= paper-based vs. recyclable plastic; D_2= bioplastic vs. recyclable plastic; PENV= perceived eco-friendliness; PCONV= perceived convenience; PI= purchase intention; GCV= green consumption values; CI= Confidence interval; ***p<0.001; **p<0.01; *p<0.05.

Table 8. Results of the conditional process analysis for vegetable oil.

Antecedent	Consequent					
	M_1 (PENV)		M_2 (PCONV)		Y (PI)	
	b (SE)	*95% CI*	*b (SE)*	*95% CI*	*b (SE)*	*95% CI*
Constant	-0.73 (0.09) ***	[-0.91; -0.56]	5.30 (0.07) ***	[5.16; 5.45]	2.50 (0.23) ***	[2.05; 2.94]
D_1	1.27 (0.13) ***	[1.01; 1.52]	-0.36 (0.11) **	[-0.57; -0.15]	-0.24 (0.11) *	[-0.47; -0.02]
D_2	0.95 (0.13) ***	[0.70; 1.20]	-0.15 (0.11)	[-0.34; 0.08]	-0.18 (0.11)	[-0.04; 0.39]
GCV	-	-	-	-	0.19 (0.06) **	[0.07; 0.31]
D_1*GCV	-	-	-	-	0.17 (0.09) *	[0.00; 0.34
D_2*GCV	-	-	-	-	0.06 (0.09)	[-0.11; 0.23]
PENV*GCV	-	-	-	-	**0.07 (0.02) ** **	**[0.03; 0.10]**
PENV	-	-	-	-	0.35 (0.03) ***	[0.29; 0.41]
PCONV	-	-	-	-	0.42 (0.04) ***	[0.35; 0.50]
	R^2 = 0.10		R^2 = 0.01		R^2 = 0.46	
	F(2, 927)=29.27, p<0.001		F(2, 927)=5.67, p<0.05		F(8, 921)= 97.22, p<0.001	

Note: D_1= paper-based vs. recyclable plastic; D_2= bioplastic vs. recyclable plastic; PENV= perceived eco-friendliness; PCONV= perceived convenience; PI= purchase intention; GCV= green consumption values; CI= Confidence interval; ***p<0.001; **p<0.01; *p<0.05.

The direct effect of **paper-based versus recyclable plastic packaging** (D_1) on purchase intention was moderated by *GCVs* for all products (H5b) (soft fruits: b=0.17, p<0.05, CI=[0.04; 0.31]; margarine/butter: b=0.29, p<0.001, CI= [0.16; 0.42]; vegetable oil: b=0.17, p<0.05, CI=[0.001; 0.34]). The effect of **bioplastic versus recyclable plastic packaging** (D_2) was only moderated by *GCVs* for margarine/butter (b=0.25, p<0.001, CI=[0.11; 0.39]). Probing these interactions shows that compared to recyclable plastic, the effect on purchase intention for paper-based packaging is higher for people with high *GCVs* but also significantly lower for people with low *GCVs*. Hence, a negative effect of packaging type on purchase intention was found for low *GCVs*. I.e., consumers with low *GCVs* indicated a lower purchase intention for the paper-based packaging compared to the recyclable plastic packaging. This could be shown for soft fruits and for margarine/butter (see Figure 5). No relevant effect was found for the category vegetable oil. Comparing bioplastic to recyclable plastic packaging, purchase intention was also significantly lower for people with lower *GCVs* and significantly higher for people with high *GCVs*.

Figure 5. Comparison of conditional means of purchase intention contingent on GCVs

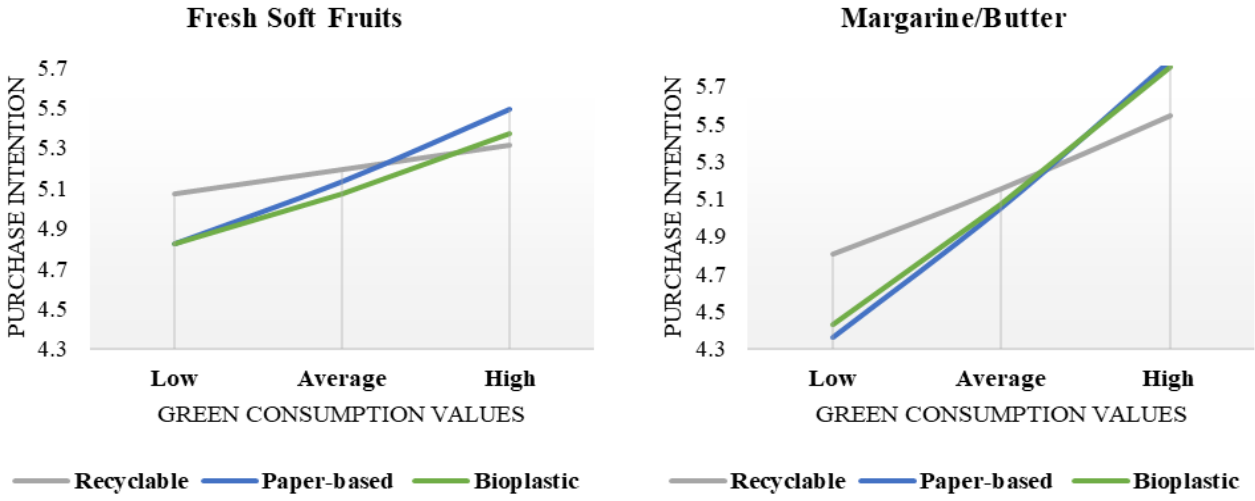


Table 9. Summary of hypotheses

Hypothesis and Description		**Cannot be rejected**
H1	*Purchase intention is higher for bio-based alternatives compared to recyclable plastic packaging.*	**Yes**, for paper-based and bioplastic of soft fruits and bioplastic packaging of vegetable oil **No**, for paper-based and bioplastic of margarine/butter and the paper-based packaging of vegetable oil
H2a	*Bio-based packaging alternatives are perceived as more eco-friendly than recyclable plastic packaging.*	**Yes**, for both packaging types and for all product categories
H2b	*The influence of packaging type on purchase intention is mediated by perceived eco-friendliness.*	**Yes**, for both packaging types and for all product categories
H3a	*Paper-based packaging for vegetable oil is perceived as less convenient than the bioplastic and recyclable plastic alternatives.*	**Yes**, for both packaging types and for all product categories
H3b	*The influence of packaging type on purchase intention is mediated by perceived convenience.*	**Yes**, for both packaging types and for all product categories
H4a	*Consumers' green consumption values positively influence the effect of packaging type on purchase intention.*	**Yes**, for paper-based packaging of all product categories and for bioplastic packaging of margarine/butter **No**, for bioplastic packaging of soft fruits and vegetable oil
H4b	*Consumers' green consumption values positively influence the effect of perceived eco-friendliness on purchase intention.*	**Yes**, for all product categories

5. DISCUSSION

This study aimed at investigating consumers' purchase intentions for two different bio-based food packaging alternatives compared to recyclable plastic packaging. We did not only test whether consumers' purchase intentions differ between different packaging types for different product categories, but also which factors influence these intentions. Thereby, the study integrates perceived eco-friendliness and perceived convenience as mediators and tested the effect of green consumption values as a relevant moderator. By exploring these factors and using the theoretical foundation of the Total Food Quality Model, the study provides a more comprehensive understanding of consumers' acceptance of different bio-based food packaging alternatives and contributes significantly to the literature on consumers' acceptance of sustainable packaging

Regarding the first research question on consumers' purchase intentions for bio-based food packaging alternatives, in line with Zwicker et al. (2023) we found a higher purchase intention for the bio-based packaging alternatives for some products. Interestingly, the purchase intention differed between the three product categories we investigated. While the paper-based alternative received the highest purchase intention for fresh soft fruits, the bioplastic alternative was preferred for vegetable oil. However, no significant differences were found for margarine/butter. We assume that people are more familiar with paper-based packaging for fresh soft fruits, making it easier to assess its eco-friendliness and convenience and to indicate their purchase intention. In contrast to the findings of Testa et al. (2021), we were able to reveal a difference in purchase intention between bioplastic and recyclable plastic bottles.

Focusing on the second research question, i.e., on the factors that influence consumers' purchase intentions for the two bio-based food packaging alternatives, the theoretical contribution of this empirical study is multifaceted. First, in conformity with the TFQ Model the findings of this study provide empirical support for the importance of consumers' perceptions such as perceived eco-friendliness in explaining consumers' purchase intention for bio-based packaging. In detail, our results reveal that the higher consumers perceived the eco-friendliness of the packaging, the higher was the purchase intention over all product categories. Thereby, our findings are in line with those of Testa et al. (2021) who showed that consumers' purchase intention for a sustainable plastic bottle increases with higher perceived eco-friendliness. By showing the mediating role of perceived eco-friendliness for all product categories, our study confirms that environmental considerations are a crucial factor for consumers' purchase intention regarding the bio-based food packaging alternatives investigated.

Moreover, we found evidence that perceived convenience is another important determinant, as suggested but not yet investigated for the case of bio-based packaging in previous studies (Dilkes-Hoffman et al., 2019; Herbes et al., 2018; Monnot et al., 2015). The results show that perceived convenience has a positive direct impact on purchase intention for all products. While we observed a positive mediation effect for fresh soft fruits, a negative mediation effect was found for vegetable oil. The higher (lower) consumers perceived the convenience of the packaging, the higher (lower) was the purchase intention. Depending on the product category, certain packaging types can decrease consumers' purchase intention as a result of a lower perceived convenience. Therefore, we recommend using a more holistic model and including both mediators in future studies about sustainable packaging alternatives. Further mediators such as perceived taste that are part of the TFQ Model could also play a role and should be assessed in future studies.

In addition to the study by Klein et al.(2019) on bioplastics in general and studies on specific bio-based products such as bio-based apparel (Klein et al., 2020) or glue sticks (Niedermeier et al., 2021), our study highlights the importance of green consumption values also for the purchase of bio-based food packaging. Moreover, we specifically analysed its moderating role. Thereby, we emphasize the relevancy of considering

not only mediators but also moderators such as green consumption values when analysing consumers' purchase intention for bio-based packaging alternatives to understand when its purchase intention is increased or even decreased. The effect of consumers' perceived eco-friendliness of the packaging on consumers' purchase intention was stronger for people with higher green consumption values. Considering fresh soft fruits and margarine/butter in particular, results show that not only high green consumption values impact purchase intention, but also low green consumption values decrease consumers' purchase intention for paper-based versus recyclable plastic packaging. Hence, we suggest promoting bio-based packaging specifically targeted towards consumers with high green consumption values. An interesting target group could be for example organic consumers.

The stronger effects for paper-based versus recyclable plastic compared to bioplastic versus recyclable plastic could be explained by the fact that benefits in terms of eco-friendliness and convenience of paper-based packaging are easier to grasp for consumers, and that it is rather difficult to distinguish characteristics of bioplastics from those of recyclable plastic. Moreover, as other studies have shown, people primarily think about the end of life characteristics such as biodegradability and recycling (Herbes et al., 2018; Mehta et al., 2021), which might be clearer for paper than for bioplastics.

Different strategies should be implemented depending on the product category as the functionality is not equal for all food products (Jinkarn & Suwannaporn, 2015; Koutsimanis et al., 2012). While paper-based food packaging is perceived as most eco-friendly, it is not always perceived as convenient and might therefore lead to rejection. Among alternatives to plastic bottles, consumers showed a skeptical view toward paper-based bottles in particular, which are increasingly researched (e.g., Coca-Cola fiber bottle). Here, it could help to increase familiarity with those paper-based bottles by prominently placing and advertising those in the supermarket and simultaneously explaining its ecological and functional benefits. Without communicating its benefits, the bioplastic bottle might be a better alternative in terms of purchase decisions. Considering fresh soft fruits, paper-based packaging appears to be the best solution for consumers. Yet, there are product categories—such as margarine/butter—where the benefits of bio-based packaging are not obvious to consumers and should therefore be communicated clearly. As findings show that if consumers do not perceive differences between the products' eco-friendliness and convenience, purchase intention could be even lower for the bio-based alternatives compared to the recyclable packaging. Hence, building awareness around the eco-benefits and convenience of bio-based packaging is a key strategy to increase its purchase intention.

Limitations of our study to be addressed in further research include the following: First, we used a hypothetical research setting with products that cannot yet be bought at the supermarket. Consequently, it may have been difficult for some participants to imagine the paper-based packaging for vegetable oil. Secondly, some consumers used glass bottles as their reference category for vegetable oil, which might have influenced their reported purchase intention. Third, we used a between-subjects design, which is frequently used in psychology research and provides, for example, benefits in reducing order-effects and the risk of fatigue (Mullet & Chasseigne, 2018). However, in a realistic supermarket setting all options would be available and could be compared simultaneously.

We did not focus on gender or age differences in our study, but investigating demographic factors could be an avenue to tailor future marketing strategies. The importance of other factors, such as price, is addressed in many studies (see the review by Ketelsen et al. (2020)) and when those different bio-based packaging are on the market, studies on WTP should be conducted. The answers to open questions in our study also showed that a higher price for sustainable packaging might be a threat to acceptance. These answers also suggest the brand as an important purchase criterion. As other studies have already shown, brands can have an important function in communicating and promoting sustainable alternatives (e.g., Reinders et al., 2017). These aspects should be

addressed in further acceptance studies. As a next step, we plan to design a lab-in-the field experiment where we can test consumers' WTP in a more realistic setting and hence address some limitations.

6. CONCLUSIONS

This study aims to contribute to understanding consumers' purchase intentions for different eco-friendly food packaging strategies. By investigating the mediating role of perceived eco-friendliness and convenience and the moderating role of green consumption values, our study sheds light on the underlying mechanisms that shape consumers' purchase intention for bio-based food packaging alternatives compared to recyclable plastic packaging for different product categories.

Our insights show that perceived eco-friendliness and perceived convenience are relevant predictors for consumers' purchase intentions to be considered in further research. The higher consumers perceived the eco-friendliness of the packaging, the higher their purchase intention. This effect was even stronger for people with higher green consumption values. Perceived convenience in particular can explain differences between product categories. While paper-based food packaging was perceived as most eco-friendly, it was not always perceived as convenient, and might therefore lead to a rejection. For fresh soft fruits, paper-based packaging appears to be the best solution for consumers. For vegetable oil, the bioplastic option received the highest purchase intention. Nevertheless, there are product categories, such as margarine/butter, where the benefits of bio-based packaging are not obvious to consumers and should therefore be communicated clearly. This study complements others in pointing towards differences between product categories and we conclude that there is no one-size-fits-all strategy. Different products require different eco-friendly packaging in order to meet consumers' expectations.

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