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Consumers' Behavior toward Packaging Containing Agricultural Waste as a Plastic Filler for Food: An Exploratory Study

Korey Fennell [1], Jack Fehlberg [1], Sukhdeep Singh [2], Laurent M. Matuana [1], Sungeun Cho [3] and Eva Almenar [1,*]

[1] School of Packaging, Michigan State University, East Lansing, MI 48824, USA; fennel22@msu.edu (K.F.); fehlber1@msu.edu (J.F.); matuana@msu.edu (L.M.M.)
[2] Department of Plant Soil and Microbial Sciences, Michigan State University, East Lansing, MI 48824, USA; singhs63@msu.edu
[3] Department of Poultry Sciences, Auburn University, Auburn, AL 36849, USA; sungeun.cho@auburn.edu
* Correspondence: ealmenar@msu.edu; Tel.: +1-517-355-3603

Abstract: Agricultural waste can be used as a plastic filler during the production of packaging, reducing the environmental impact and raw material consumption while supporting the circular economy. Despite so many efforts being made in development and characterization, consumers' behavior toward packaging containing agricultural waste as a plastic filler for food is still unknown. The aim of this study was to investigate consumers' awareness of and liking for packaging containing agricultural waste as a plastic filler and consumers' perception and purchase intent of food in such packaging. Consumer survey research was conducted using an in-person questionnaire containing Likert scale, hedonic scale, and guide-type questions completed by 86 participants after showing them bread packaged in pouches made of plastic containing agricultural waste and a prompt in August of 2019. The responses were first analyzed as a whole and further evaluated using demographic and psychographic characteristics. Participants liked the use of agricultural waste to produce food packages and were willing to purchase food (bread) in this novel packaging. The aspect "reduction of harmful environmental impacts" was very important to participants if they were to purchase packaging containing agricultural waste. About 50% of participants were unsure of the performance of this packaging in terms of food quality and safety and >25% perceived no effect. Differences ($p \leq 0.05$) within the groups for specific demographic and psychographic characteristics and two-way interactions between them were found. This study shows that food packaging containing agricultural waste should be well received and that packaging choices that affect the environment, like packaging containing agricultural waste, depend on consumers' mindset. Thus, educating consumers could contribute to reducing the packaging impact on the environment and to boosting environmentally friendly packaging acceptance.

Keywords: food packaging; byproduct; awareness; perception; liking; purchase intent; demographics and psychographics

Citation: Fennell, K.; Fehlberg, J.; Singh, S.; Matuana, L.M.; Cho, S.; Almenar, E. Consumers' Behavior toward Packaging Containing Agricultural Waste as a Plastic Filler for Food: An Exploratory Study. *Sustainability* **2024**, *16*, 1126. https://doi.org/10.3390/su16031126

Academic Editors: Iosif Botetzagias, Eftichios Sartzetakis and Antonis Skouloudis

Received: 1 January 2024
Revised: 23 January 2024
Accepted: 26 January 2024
Published: 29 January 2024

1. Introduction

Packaging can ensure food safety and freshness if well designed [1]. However, the materials used to produce food packages can negatively affect the environment if they do not contribute to a packaging circular economy and end up in landfills and waterways [1]. Thus, the packaging industry across the globe is experiencing a significant transformation driven by regulations targeting the reduction of the impact of plastic on the environment (e.g., Directive 94/62/EC on packaging and packaging waste in Europe [2] and the single-plastics prohibition regulations in Canada [3]) and the increasing number of consumers seeking brands that prioritize environmentally friendly practices [4]. Businesses, government agencies, research institutes, and other stakeholders have come together to form

foundations, pacts, organizations, and alliances, such as the Ellen MacArthur Foundation, the U.S. Plastic Pact, Ameripen, and GreenBlue, to increase the sustainability of packaging in accordance with the growing demand for it. The ultimate goal is both to reduce the carbon footprint and promote the circular economy. An overview of the current landscape of sustainable food packaging, including definitions, drivers, changes, actions, applications, and limitations, was reported in our previous paper [1].

A common material that food packages are made of is plastic [1]. Conventional plastic packaging is regarded as one of the main environmental hazards due to its difficulty of disposal without harm to the environment [1]. A possible solution to this waste problem is to create environmentally friendly food packaging. Different types of environmentally friendly packaging have been investigated for food, including reusable packaging, recyclable packaging, biodegradable packaging, compostable packaging, and bio-based packaging [1,5,6]. More recently, packaging made of plastic filled with agricultural waste (AW) has been developed as another solution to this waste problem. Using AW as a plastic filler reduces plastic and contributes to a circular economy and waste management [1]. Due to the potential outcomes, research on developing packaging containing AW as a plastic filler has grown significantly during the last decade [7–9]. AW generated from the processing of cereals, legumes, fruits, and vegetables like stalks, leaves, hulls, and peels has been investigated as a plastic filler [7]. Work previously performed by our research team has demonstrated that orange peel from juicing can be used as a filler for plastics commonly used in food packaging that are not renewable, such as linear low-density polyethylene [10]. Other researchers have demonstrated that other AWs can be used as fillers for many other plastics [7,8]. Despite so many efforts being made in the development and characterization of packaging containing agricultural waste as a plastic filler, consumers' behavior toward this type of packaging is still unknown. An exhaustive review of the literature revealed that there is no knowledge concerning consumers' awareness, liking, preference, and purchase intent of packaging with agricultural waste as a plastic filler for either a whole population or just a group from it. However, the success of this novel packaging hinges on consumers' acceptance, as shown for other types of environmentally friendly packaging in Section 1.1.

1.1. Literature Review on Consumers' Behavior toward Environmentally Friendly Food Packaging

Research has been conducted on consumers' awareness, liking, preference, purchase intent, and willingness to pay for biodegradable, bio-based, recyclable, and reusable packaging, as discussed below. These studies have been performed because consumers play a significant role in the market penetration of environmentally friendly food packaging. Previous research has shown that bio-based packaging and biodegradable packaging are preferred over petroleum-based packaging for a variety of food products. For example, Orset et al. [11] reported that French consumers were more willing to pay for water bottles made of polylactic acid (PLA, biodegradable) than those made of polyethylene terephthalate (PET, non-biodegradable). Despite consumers' preference for biodegradable packaging, they are not always able to recognize this type of packaging [12]. Koutsimanis et al. [13] found that US consumers preferred fresh produce packaged in containers made of bio-based plastics compared to petroleum-based plastics. However, the literature also reports that consumers have a limited understanding of bioplastics [14] and that some consumers (e.g., Japanese consumers) do not prefer all their aspects (e.g., use of biomass) [14].

Although the literature reports that consumers find biodegradable packaging more advantageous than recyclable packaging regardless of the food product [15], consumers have a positive perception of recyclable packaging. For example, Portuguese consumers strongly agreed on the use of recycled materials for food packaging [16]. Consumers are also willing to pay for packaging made of recycled materials. Orset et al. [11] reported that French consumers expressed their highest willingness to pay for water bottles made of recycled PET when this material was compared to other materials. Klaiman et al. [17] found that there is a market for and willingness to pay for recyclable plastic packaging for fruit juice in the US. Heiniö et al. [18] reported that the recyclability of the containers

for ready-made meals was one of the four packaging features most valued by Finnish and Dutch seniors.

Research on reusable packaging has reemerged starting in 2018, showing consumers' acceptance of this type of packaging [19]. Long et al. [20] reported that English consumers are in favor of reusable food product packaging strategies. Similarly, Miao et al. [21] reported that European consumers approve of and voluntarily adopt reusable food packaging. Herbes et al. [22] reported that German consumers perceived reusable packaging as more environmentally friendly packaging than recyclable packaging, while US and French consumers did not. Neill and Williams [23] concluded that the US consumers' preference for returnable glass bottles over paperboard gable-top packaging and plastic jugs for milk is due to the perception that returnable bottles are helpful for the environment.

The psychographic and demographic characteristics of consumers influence their purchasing decisions [24]. Hence, demographic and psychographic segmentation is becoming a trending packaging strategy as it is very important to create packaging that appeals to every population group and fulfills the needs of the whole population. The literature shows the importance of studying population groups to understand differences in behavior toward different types of environmentally friendly food packaging that can propel the use of this emerging packaging. Orset et al. [11] found that women have a higher "willingness to pay" for biodegradable water bottles compared to men. Likewise, other gender-focused studies concluded that women are more environmentally conscious than men since they tend to take the sustainability of the packaging into account when purchasing products [25,26]. Baruk and Iwanicka [27] reported that the importance of the ecological features of dairy product packaging for Polish consumers increased based on their age. Koutsimanis et al. [13] identified that older US consumers preferred bio-based over petroleum-based plastics for produce compared to younger consumers. These authors also reported that US consumers with graduate degrees recognize the impact of packaging on the environment based on its disposal method compared to high school and college graduates. Bajonowska and Sulimierska [12] found that the recognition of biodegradable packaging for organic chocolate depends only on the age and education level of the Polish consumer. Consumers' age also affects how willing they are to pay for recyclable fruit juice packaging, with older and younger consumers being more eager to pay for this type of packaging [17]. On the other hand, Luu and Baker [28] reported that Vietnamese consumers who expressed a greater concern for the environment were more likely to purchase packaging made of recyclable materials. Similarly, Jeżewska-Zychowicz and Jeznach [25] found that Polish consumers with more positive attitudes toward the environment favor the reduction of the amount of packaging waste, and Van Birgelen et al. [29] found that environmentally friendly packaging for beverages is more appealing to German consumers who are more in favor of environmental preservation.

1.2. Proposed Research and Research Questions

While consumers' attitudes toward and preferences for biodegradable packaging, bio-based packaging, recyclable packaging, and reusable packaging have been investigated widely, as discussed in Section 1.1, there is no information in the literature on consumers' behavior toward packaging containing AW as a plastic filler, an emerging environmentally friendly packaging for food. According to Ketelsen et al. [30] and Ruf et al. [31], there are different affective and cognitive processes that occur from "exposure" to the "purchase" of environmentally friendly packaging. These processes are awareness, knowledge/perception, liking, and conviction, and all of them are involved before a consumer makes a purchase. Hence, getting to know consumers' awareness, perception, liking, and purchase intent for packaging containing AW as a plastic filler for food is necessary to understand the market penetration (purchase) of this emerging environmentally friendly packaging. To close this knowledge gap, the following research questions (RQ) were formulated:

RQ1: How important is the environmental impact of the package's material and how does this compare to the package's cost, aesthetics, and performance for a population as a whole and among its different population groups? This research question was formulated to investigate consumer awareness from a broader point of view (environmental impact of the material in general) compared to RQ2.
RQ2: What is the importance of the environmentally friendly aspects "add value to discarded materials", "waste management", "new packaging", "greener packaging", and "reduction of harmful environmental impacts on water, air, or soil" in relation to buying packaging containing AW for the whole population and among different population groups? This research question was formulated to investigate consumer awareness from a narrower point of view (specifics with an impact on the environment) compared to RQ1.
RQ3: What is the liking for using AW for food packaging as a whole population and among different population groups? This research question was formulated to investigate consumer liking.
RQ4: What perception do consumers have of the effect of packaging containing AW on food shelf life and safety as a whole population and among different population groups? This research question was formulated to investigate consumer knowledge/perception.
RQ5: How likely is the population as a whole and as different groups to purchase bread in packaging containing AW? This research question was formulated to investigate consumer conviction.
RQ6: What is the percentage that specific food categories are purchased in environmentally friendly packages by the whole population and different population groups? This research question was formulated to investigate consumer purchase to be used for comparison purposes.

To answer these research questions, this study investigated consumers' awareness and liking of packaging containing agricultural waste as a plastic filler as well as consumers' perception and purchase intent of food in such packaging. This was achieved by analyzing consumers as both a whole population and population groups. The paragraph focused on consumers' demographics and psychographics in Section 1.1. shows that age, gender, education level, ethnicity, and attitude toward the environment are the population characteristics that the literature commonly reports to show differences when decisions on environmentally friendly packaging are taken. Hence, these demographic and psychographic characteristics were selected for the consumers in this study. Furthermore, this study used two different stimuli formats: text stimuli and product stimuli to expose consumers to the packaging under study. The text stimuli consisted of a prompt (Section 2.3) and the product stimuli consisted of bread inside pouches made of plastic containing orange peels, allowing the study's participants to engage with the novel packaging. Besides exposure, the latter overcomes the limitations of studies delving into consumers' purchase of environmentally friendly packaging, like consumers not being able to recognize the type of packaging under study [32], consumers taking online surveys not providing data on real purchase behavior [13,32], and consumers taking online surveys being exposed to verbal descriptions of the packages rather than to the actual packages [11,13,17].

2. Methodology

2.1. Conceptual Framework

This study applied the same conceptual framework as Ketelsen et al. [30] and Ruf et al. [31], which has already been introduced in Section 1.2. when the authors mentioned it. This conceptual framework was adapted from Grunert [33], who was inspired by the "Hierarchy of Effects Theory" developed by Lavidge and Steiner [34]. Following the line of thinking of Ketelsen et al. [30] and Ruf et al. [31], this study's framework assumes that participants' exposure to packaging containing AW as a plastic filler will generate cognitive processes (awareness and perception) that will result in affective processes (liking) and both types of processes will affect participants' purchase intent. Furthermore, this study's framework also assumes that these cognitive and affective processes may happen

simultaneously and influence each other and that they are also influenced by participants' demographic and psychographic characteristics.

2.2. Participants

Eighty-six consumers participated in this study. They were recruited from the state of Michigan (MI) using an online research participation system (SONA, East Lansing, MI, USA). This sample size was selected because the optimal size for a consumer panel ranges between 75 and 100 [35]. A consumer panel was chosen to show food in packaging containing AW to the survey participants to gather more reliable data (e.g., to avoid responses based on imagination or misinformation). The SONA system was used for the screening process. Only regular bread consumers who were 18 years old or older were recruited. The participants were asked to sign a consent form and then seated individually in sensory booths in the Michigan State University (MSU) sensory lab. The SIMS 2000 Sensory Evaluation Testing Software (Sensory Computer Systems, Berkeley Heights, NJ, USA) was used to provide participants with instructions, questions, and the ability to input responses. The study was approved by the Institutional Review Board of MSU and performed in summer 2019.

2.3. Questionnaire

A two-part questionnaire was administered to each participant. The first portion of the questionnaire consisted of a list of ordinal scales and categorical questions (Likert scale, hedonic scale, and guide-type questions) to assess the panelist's behavior toward environmentally friendly food packaging, specifically the use of AW in food packaging. Bread was used as the food model of a packaged food product for specific questions because: (1) of the familiarity of the participants with this food product, (2) it is a staple food product in the US, and (3) it is commercialized in a polyethylene flexible pouch in the US. The details of these questions are provided in Section 2.4. The second portion of the questionnaire included questions in the form "choose one guide-type response" to gather participants' demographic segmentation (gender, age, ethnicity, education) and psychographic segmentation (environmental consciousness).

2.4. Data Collection

Participants responded to a total of 28 questions that covered the following topics:

- the importance of the attribute material impact on the environment compared to cost, aesthetics, and performance for a food package,
- the importance of the aspects "add value to discarded materials", "waste management", "new packaging", "greener packaging", and "reduction of harmful environmental impacts on water, air, or soil" on buying packaging produced with AW,
- consumers' perception of the effect of packaging containing AW on food (bread) shelf life and safety,
- the liking of the use of AW for food packages,
- the purchase frequency of several food categories in environmentally friendly packaging,
- the purchase intent of food (bread) in packaging containing AW.

Before responding to the questions, participants were given sliced bread packaged in pouches made of plastic films containing orange peels, which were produced as described by [9], and then a prompt was shown on their computer screens. The prompt informed the participants that the bread was packaged with materials containing AW from the orange juicing industry that are generally discarded to reduce the amount of non-renewable petroleum-based plastics needed for film production commonly used for bread packaging.

For the sections of the questionnaire about the importance of aspects and attributes when buying packaging containing AW or packaging in general, a five-point importance Likert scale was used, ranging from not at all important (1) to extremely important (5). For the sections of the questionnaire about consumers' purchase intent of food packaged with AW and their preference for the combination of plastic and AW for food packaging,

a seven-point likelihood Likert scale from extremely unlikely (1) to extremely likely (7) and a nine-point hedonic scale from dislike extremely (1) to like extremely (9) were used, respectively. For the section of the questionnaire about consumers' purchase frequency of different food categories packaged within environmentally friendly packaging during shopping, a 5-point frequency Likert scale from all the time (1) to never (5) was used. For the sections of the questionnaire about the possible effect of packaging produced with AW on the shelf life and safety of packaged food (bread), guide-type responses that include decrease (1), no effect (2), increase (3), and I do not know (4) were used.

2.5. Statistical Analysis

The participant data collected from SIMS 2000 were analyzed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). A generalized mixed-model analysis of variance (ANOVA) (PROC GLIMMIX in SAS 9.4) was used for individual population groups (i.e., age, gender, education, ethnicity, and environmentally conscious) and the two-way interactions between these population groups. For the pairwise comparison of each independent variable, the Tukey method was used at a significance level of $p \leq 0.05$ to avoid inflation of the Type-I error. The post hoc comparison for the two-way interactions was performed by writing contrasts for each combination of levels of population groups.

3. Results

3.1. Population Demographics and Psychographics

The demographic and psychographic breakdown of the survey participants is presented in Table 1. The dominant groups within the demographic breakdown were females and Caucasians. The female predomination resulted from the recruitment criterion. In surveys when the standard recruiting criteria relate to who does most of the household purchasing, women are frequently overrepresented [36]. The Caucasian predomination (62.8%) can be explained by this being the largest ethnicity in the current US population [37]. Similar gender and ethnicity distributions have been reported in other studies focused on packaging [25,26,38]. Most of the participants had completed college or a higher degree. Furthermore, they were a fair representation of different generations, including Baby Boomers and Generation X (38.4%), Millennials (38.5%), and Generation Z (23.3%), which provided enough generational diversity to investigate differences in behavior among generations. A similar representation of generations is shown in Jeżewska-Zychowicz and Jeznach's [25] study on how Polish consumers' attitude toward the environment affects behaviors related to choosing food products, taking into consideration packaging. The psychographics of this study show that approximately 41% of the participants identified themselves as "environmentally conscious" and about half of the participants identified themselves as "maybe/sometimes". A similar split for consumers' attitudes toward the environment on packaging has been reported in [25].

Table 1. Panelist demographic and psychographic breakdown (n = 86).

Variables		Participants (%)
Gender	Female	66.3
	Male	33.7
Age	18–24	23.3
	25–35	38.4
	36 or older	38.5
Ethnicity	White	62.8
	Hispanic, Latino Spanish	7.0
	Black or African American	2.3
	Asian or Asian Indian	26.7
	American Indian or Alaska Native	1.2

Table 1. *Cont.*

Variables		Participants (%)
Education	Less than high school	0.0
	High school graduate	4.7
	Some college	5.8
	2-year degree	5.8
	4-year degree	36.0
	Masters	39.5
	Doctoral	5.8
	Professional Degree	2.3
Environmentally conscious	Yes	41.8
	No	6.9
	Maybe/Sometimes	51.1

3.2. Importance of Packaging Material Impact on the Environment

Over the years, food packaging designed to be competitive has been constructed with cost, aesthetics, and performance in mind. The "material impact on the environment" is a more recent decision criterion resulting from growing environmental concerns [39]. Currently, the importance of packaging's material impact on the environment is unknown compared to the cost, aesthetics, and performance of the package. Thus, the importance of these four packaging attributes was rated for comparison purposes (Table 2).

Table 2. Importance of the "material impact on the environment" compared to the key attributes of food packaging design (n = 86).

Attributes	Responses (%)					Likert Scores [1]
	Not at All Important	Slightly Important	Moderately Important	Very Important	Extremely Important	
Cost	1.2	5.8	38.4	40.7	14.0	3.6
Aesthetics	3.5	25.6	43.0	25.6	2.3	2.9
Performance	0.0	5.8	16.3	59.3	18.6	3.9
Material impact	2.3	18.6	36.0	29.1	14.0	3.3

[1] Likert scores refer to the mean values of the used Likert scale.

"Performance" was rated the most important attribute in a food package (Likert score = 3.9). Specifically, the bulk of participants (~80%) rated "performance" as either very important or extremely important. "Cost" was rated the second most important packaging attribute (Likert score = 3.6), with 55% of the participants rating "cost" as either very important or extremely important. In contrast, previous surveys have found that price is the factor that influences the most consumers in the purchase of a packaged food product [13,29].

The "material impact on the environment" rated third in importance (Likert score = 3.3). Moderately important was the level of importance most selected by the participants (36%) for this attribute. The preference of consumers for "cost" over the "material impact on the environment" has previously been reported for beverage packaging [29]. Our findings demonstrate that the same is true for food packing. This lower importance of the "material impact on the environment" compared to "performance" and "cost" could have resulted from either the limited knowledge consumers have about the influence of packaging on the environment [40] or the consumers' assumptions about how environmentally friendly different packaging materials are [32].

"Aesthetics" was the packaging attribute with the lowest importance for the panelists (Likert score = 2.9). This indicates that consumers place more of an emphasis on the actual package performance, cost, and impact on the environment than on its visual beauty. However, aesthetics still must be considered when designing packaging that conveys a message, as shown by the literature. Scott and Vigar-Ellis [41] reported that South African consumers believe that "earth" colors such as cream, brown, or green are indicators of sustainability or environmentally friendly packaging. Also, plain packaging with only ink or a little color is viewed as environmentally friendly. Furthermore, Magnier et al. [42], who investigated the influence of environmentally friendly packaging on French consumers' perceived product quality and product naturalness, reported that the food products under study (coffee, chocolate, and raisins) were perceived to be significantly better when the packaging looked more sustainable (package with a recycled cardboard look).

The importance of the impact of the packaging material on the environment was different ($p \leq 0.05$) depending on the participant's age and environmental consciousness (Figure 1). The youngest participants rated the material impact on the environment higher in importance than the oldest participants ($p \leq 0.05$) (Figure 1). This shows that interest in protecting the environment is greater among younger generations. In agreement, Yadav and Pathak [43] reported that Indian youth have serious environmental concerns and prefer to purchase green products. The participants who declared themselves as environmentally conscious rated the higher importance of the impact of the packaging material on the environment ($p \leq 0.05$). Similarly, Jeżewska-Zychowicz and Jeznach [25] found that Polish consumers with more positive attitudes toward the environment favor the reduction of the amount of packaging waste.

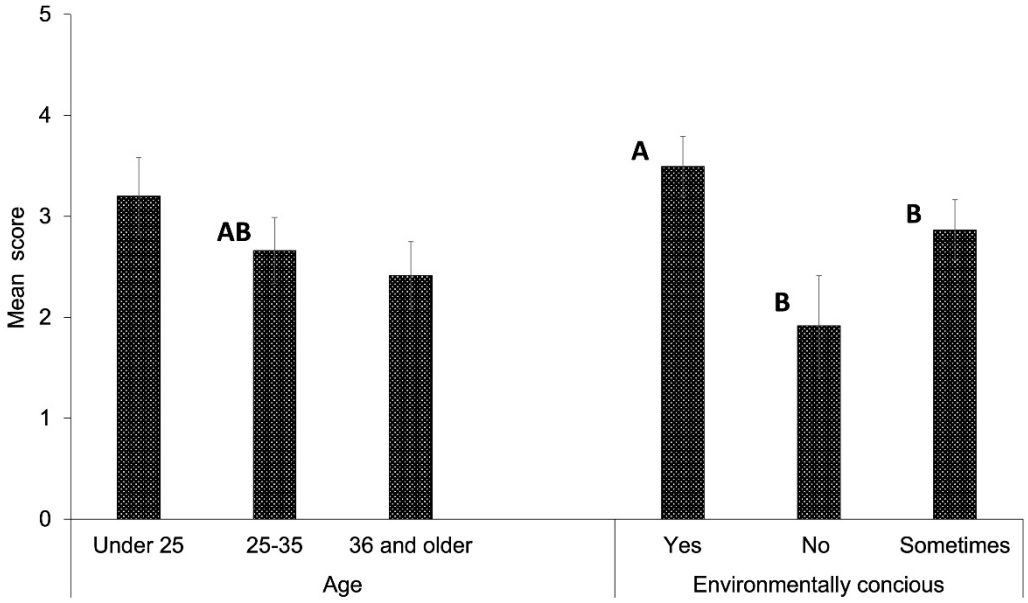

Figure 1. Importance of the impact of the packaging material on the environment based on participants' age and environmental consciousness. Different letters indicate a significant difference within age and environmental consciousness at $p \leq 0.05$. Use of a five-point importance Likert scale ranging from Not at all important (1) to Extremely important (5).

Two two-way interactions between gender and environmental consciousness were found (Figure 2). The female participants who identified themselves as environmentally conscious considered the impact of the packaging material on the environment to be more important than the female participants who declared themselves either sometimes or not environmentally conscious (3.9 vs. 3.1; $p = 0.0035$ and 3.9 vs. 1.5; $p = 0.0049$, respectively). Comparing the last two groups, the female participants who declared themselves sometimes environmentally conscious considered the impact of the packaging material

on the environment more important than the females who identified themselves as not environmentally conscious (3.1 vs. 1.5; $p = 0.0181$) (Figure 2). These results show consistency between identification and behavior. In contrast, the importance of the impact of the packaging material on the environment was the same for all the males, regardless of how environmentally conscious they were. Likewise, Jeżewska-Zychowicz and Jeznach [25] found that out of the two population clusters that their population was split into, the cluster representing consumers with more positive attitudes toward the environment consisted of women in a greater proportion.

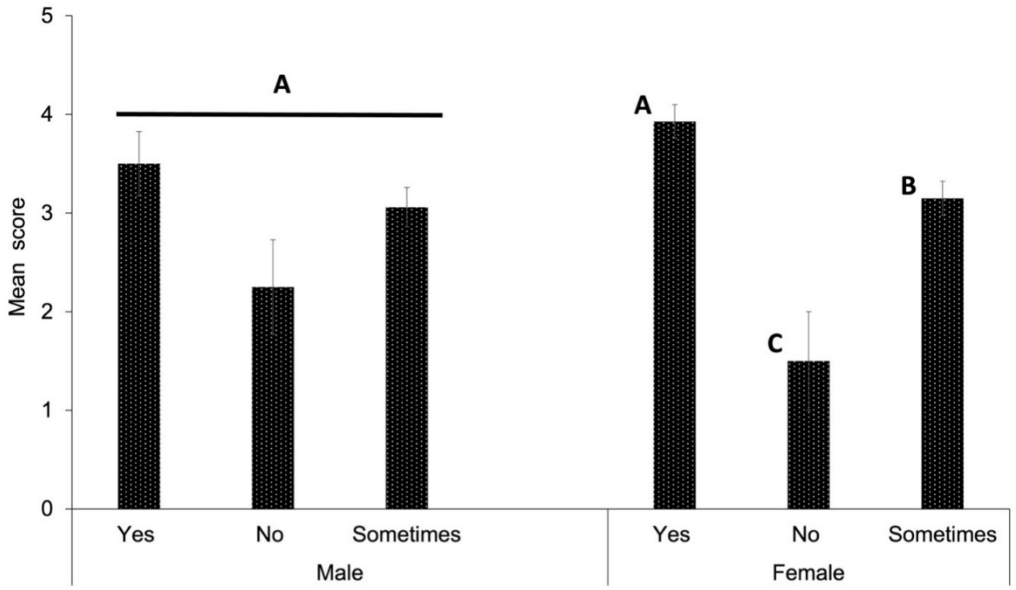

Figure 2. Gender*environmentally conscious interactions for the importance of the "material impact on the environment" for a food package. Different letters indicate a significant difference within "environmentally conscious" for the same gender at $p \leq 0.05$. The same Likert scale from Figure 1 was utilized.

Our and others' results [25,44] indicate that packaging choices that affect the environment depend on consumers' mindset for specific groups within demographic characteristics. Therefore, targeted consumer education could contribute to reducing the impact of packaging on the environment. The groups within demographic characteristics did not differ in how important the attributes "cost", "aesthetics", and "performance" are on a food package. In contrast, Wilson et al. [38] found that the willingness to pay for a food package is highly influenced by gender and age.

3.3. Importance of Environmentally Friendly Aspects to Buying Packaging Containing AW

After knowing the importance of the impact of the packaging material on the environment in Section 3.2. (consumer awareness from a broader point of view), the importance of specific environmentally friendly aspects associated with packaging containing AW was investigated (consumer awareness from a narrower point of view). Specifically, the importance of the aspects "add value to discarded materials", "waste management", "new packaging", "greener packaging", and "reduction of harmful environmental impacts on water, air, or soil" ("reduction" from now on) on buying packaging containing AW was determined (Table 3). As explained in Section 2.1, our framework assumes that participants' exposure to packaging containing AW as a plastic filler will generate awareness that will affect participants' purchase intent.

Table 3. Importance of environmentally friendly aspects on buying packaging containing AW (n = 86).

Aspects	Responses (%).					Likert Scores [1]
	Not at All Important	Slightly Important	Moderately Important	Very Important	Extremely Important	
Add value to discarded materials	7.0	7.0	47.7	26.7	11.6	3.3
Waste management	2.3	4.7	23.3	43.0	26.7	3.9
Greener packaging	2.3	11.6	15.1	46.5	24.4	3.8
Reduction	2.3	5.8	11.6	37.2	43.0	4.1

[1] Likert scores refer to the mean values of the used Likert scale.

The survey participants rated "reduction" as a very important environmentally friendly aspect for packaging containing AW (Likert score = 4.1). This score resulted from approximately 80% of the participants rating "reduction" as either very important or extremely important. The importance of "reduction" was significantly different ($p \leq 0.05$) based on the panelists' gender and environmental consciousness (Figure 3). Female participants rated "reduction" as more important than male participants. This could be because women are more interested in preserving the environment. Jeżewska-Zychowicz and Jeznach [25] reported a greater proportion of women in a population cluster that represented consumers with more positive attitudes toward the environment. Participants who identified themselves as environmentally conscious rated the aspect "reduction" higher than non-environmentally conscious participants and participants who responded sometimes. Furthermore, participants who identified themselves as sometimes environmentally conscious rated this aspect higher than non-environmentally conscious participants. Similarly, Trivium Packaging [45] highlights that among 15,000 consumers across Europe, North America, and South America, the ones who identified themselves as environmentally conscious (70%) placed importance on the reduction of the harmful impact of packaging on the environment. Approximately 57% of those consumers reported that they are less likely to buy products in packaging they consider harmful to the environment. Additionally, 41% of those consumers declared they "won't buy" products in packaging that is harmful to the environment [45].

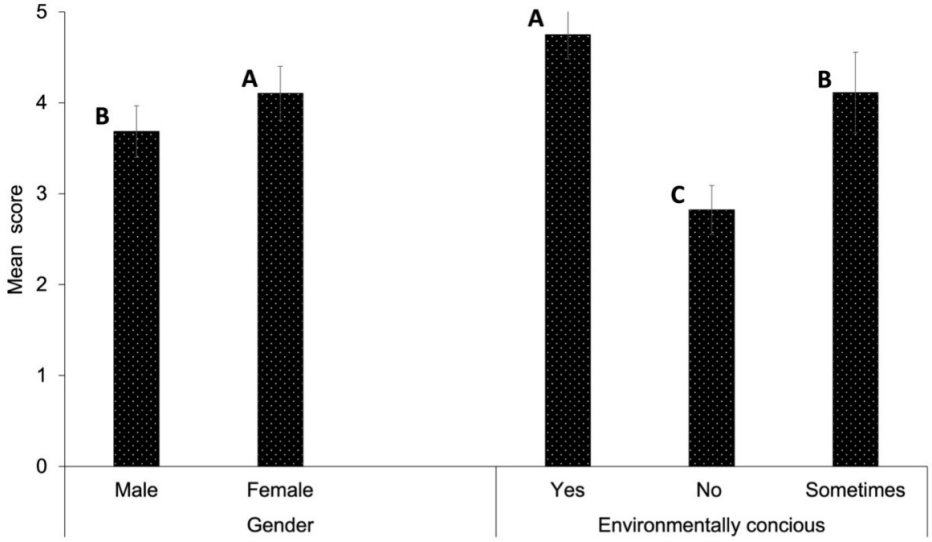

Figure 3. Importance of the aspect "reduction" when purchasing packaging containing AW based on participants' gender and environmental consciousness. Different letters indicate a significant difference within gender and environmentally conscious at $p \leq 0.05$. The same Likert scale from Figure 1 was utilized.

Two two-way interactions showed that both female and male participants who declared themselves as environmentally conscious rated "reduction" as more important than participants of the same gender who declared themselves as sometimes or not environmentally conscious ($p = 0.0005$, $p = 0.0393$, $p = 0.0033$, and $p = 0.0145$, respectively) (Figure 4). In addition, female participants who declared themselves as sometimes environmentally conscious rated "reduction" as more important compared to female participants that declared themselves as not environmentally conscious ($p = 0.0019$).

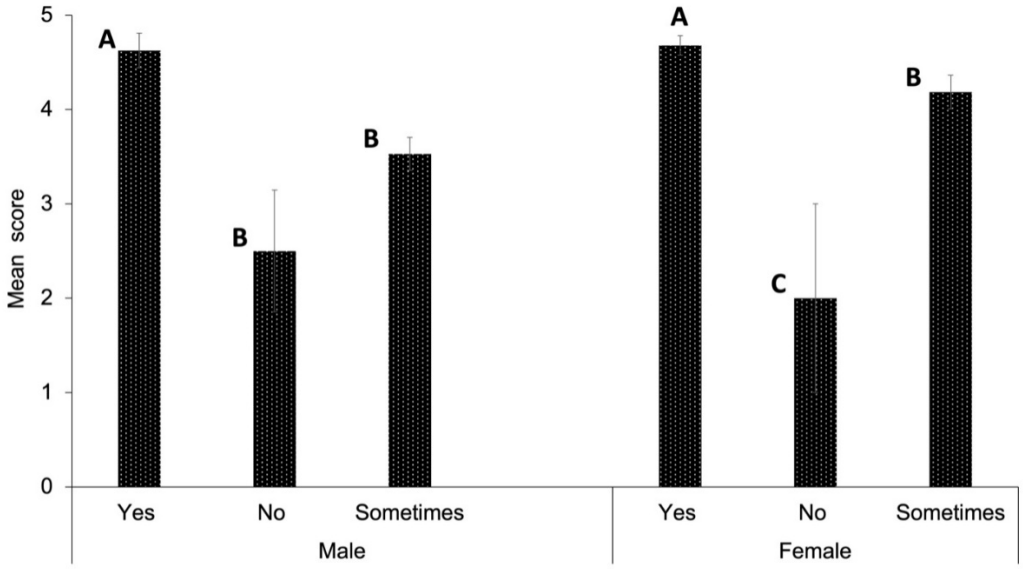

Figure 4. Gender*environmentally conscious interactions for "reduction" when purchasing packaging containing AW. Different letters indicate a significant difference within environmentally conscious for the same gender at $p \leq 0.05$. The same Likert scale from Figure 1 was utilized.

The second highest rated environmentally friendly aspect for packaging containing AW was "waste management" (Table 3), with a Likert score of 3.9 (border between moderately important and very important). This score resulted from 70% of the participants rating this aspect as either very important or extremely important for packaging containing AW. The importance of "waste management" was significantly different ($p \leq 0.05$) based on the environmental consciousness of the participants, similarly to the aspect "reduction". Participants who identified themselves as environmentally conscious rated packaging containing AW being able to manage waste higher than participants who considered themselves as sometimes or not environmentally conscious.

"Greener packaging" had a Likert score of 3.8, indicating that the fact of packaging containing AW being greener packaging is moderately important for consumers. The importance of greener packaging when purchasing packaging containing AW was significantly different ($p \leq 0.05$) based on the panelists' age, gender, and environmental consciousness (Figure 5). The results show participants under 25 placed more importance on packaging containing AW being greener than participants 36 and older. Female participants deemed this aspect more important opposed to male participants. Similarly, Martinho et al. [26] found that Portuguese women were more inclined to embrace sustainable packaging in general compared to men. Participants who identified themselves as environmentally conscious rated "greener packaging" higher than participants who considered themselves as sometimes or not environmentally conscious. Also, participants who identified themselves as sometimes environmentally conscious rated "greener packaging" higher than participants who considered themselves as not environmentally conscious. Two two-way interactions were found between gender and environmental consciousness. Both male and female participants who identified themselves as environmentally conscious rated greener packaging as more important than the same gender of participants who declared

themselves either sometimes or not environmentally conscious (p = 0.0027, p = 0.0009, p = 0.0011, p = 0.0020, respectively). Also, female participants who identified themselves as not environmentally conscious rated greener packaging as less important than females who declared themselves sometimes environmentally conscious (p = 0.0082) (Figure 6).

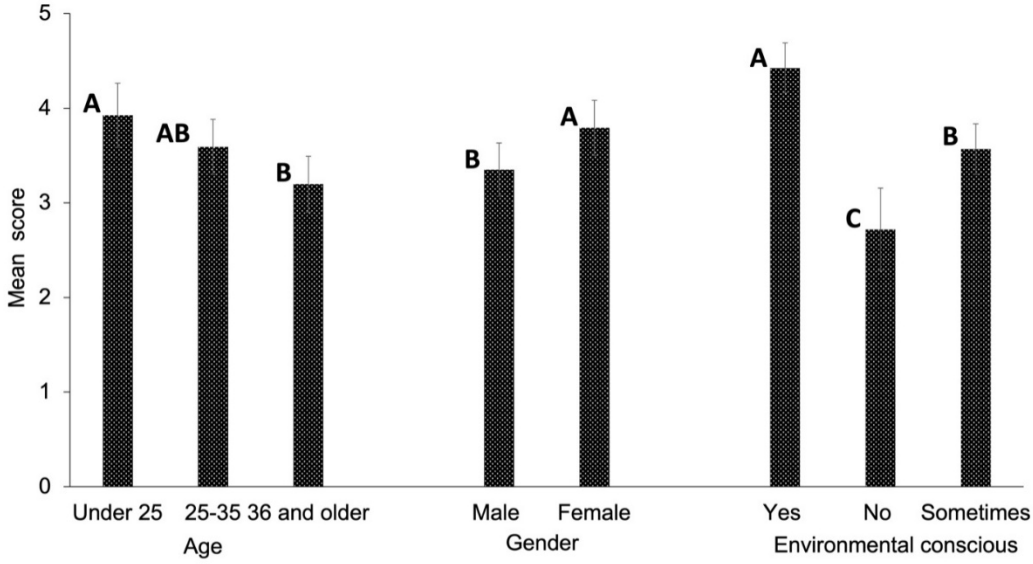

Figure 5. Importance of "greener packaging" when purchasing packaging containing AW. Different letters indicate a significant difference within age, gender, and environmental conscious at $p \leq 0.05$. Use of the same Likert scale as in Figure 1.

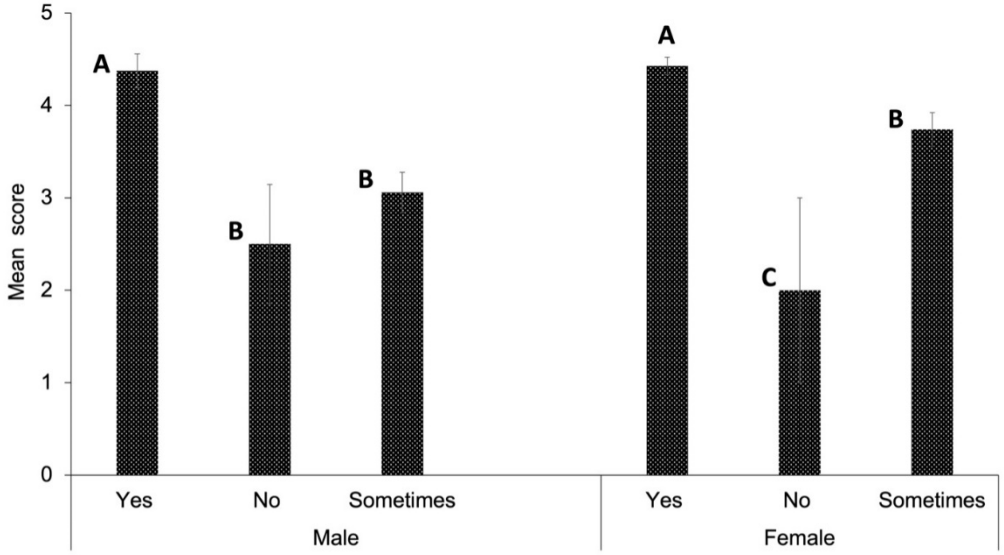

Figure 6. Gender*environmentally conscious interactions for the importance of "greener packaging" when purchasing packaging containing AW. Different letters indicate a significant difference within environmentally conscious for the same gender at $p \leq 0.05$. The same Likert scale from Figure 1 was utilized.

"Add value to discarded materials" was another moderately important aspect for packaging containing AW (score = 3.3). Thus, "add value to discarded materials" was rated as much less importance than "waste management", although it is a type of waste management. This indicates that some participants were not able to see the connection. Educating consumers would help them to understand the positive benefits that adding value to discarded materials brings to the environment. The importance of "add value

to discarded materials" was significantly different ($p \leq 0.05$) based on the environmental consciousness of the participants, as reported for the previous aspects.

Based on the above, all the key environmentally friendly aspects related to packaging containing AW were more important for participants who identified themselves as environmentally conscious compared to non-environmentally conscious participants. Therefore, if an emphasis is placed on educating consumers about environmental issues caused by packaging, all the key environmentally friendly aspects covered by this study could possibly receive an increase in importance due to consumers' environmental awareness. Some of the studied aspects differed in importance based on gender and age; however, none of these aspects differed in importance based on the education level or ethnicity of the panelists. In contrast, Mancini et al. [46] found that Italian participants with medium to low levels of education show little interest in sustainable packaging materials compared to those that had a higher level of education. Furthermore, Jeżewska-Zychowicz and Jeznach [25] reported that out of two population clusters that the participants were split into, the cluster representing Polish consumers with more positive attitudes toward the environment consisted of people with higher education in a greater proportion.

3.4. Liking of the Use of AW for Food Packages

Following assessment of the importance of the impact of the packaging material on the environment, panelists were asked to indicate their liking of the use of AW to produce food packages. The results are presented in Figure 7. A total of 52% of the participants recorded a "liking" response that ranged from "like slightly" to "like extremely" (Figure 7). However, the average Likert score was 6 ("like slightly") out of 9 due to the substantial portion of participants (25%) who showed a neutral position in the use of AW for food packaging. The unknown performance of the novel material (Section 3.5) may have been the reason for the significant number of consumers with a neutral position. As discussed previously, packaging performance is more important than the impact of the packaging material on the environment. Overall, these results indicate that food packages containing AW should be well perceived by a large proportion of consumers.

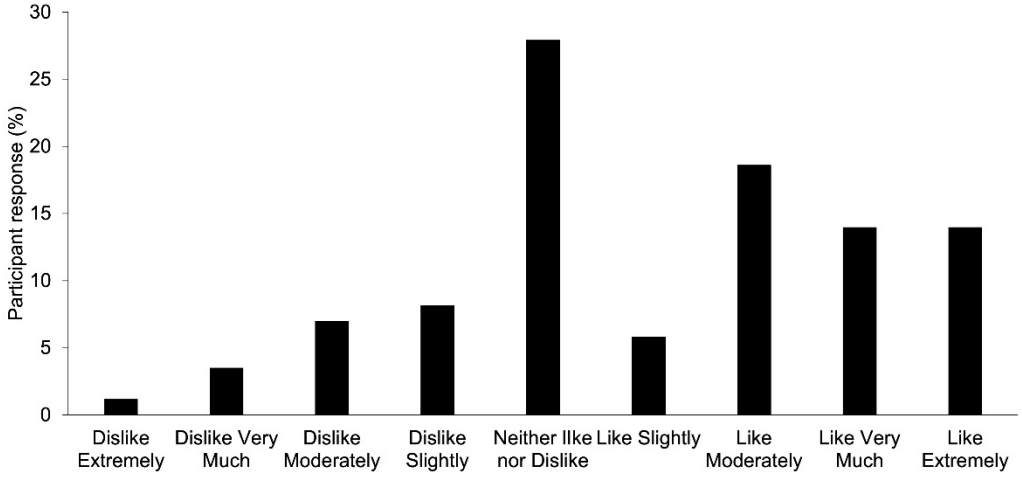

Figure 7. Participants' liking of the use of AW for food packages. Use of a nine-point hedonic scale from Dislike extremely (1) to Like extremely (9).

The liking of the combination of AW and plastic for food packaging was significantly different ($p \leq 0.05$) depending on the participants' gender and environmental consciousness. Male participants were more receptive ("like moderately") toward this packaging combination compared to their female counterparts ("neither like nor dislike") (Figure 8). Similarly, Wilson et al. [38] found females less willing to accept packaging changes. Participants who identified themselves as environmentally conscious were more in favor of this novel packaging as well (Figure 8) than those who indicated themselves to be environmentally

conscious sometimes. Similarly, Van Birgelen et al. [29] found that environmentally friendly packaging for beverages is more appealing to German consumers who are more in favor of environmental preservation.

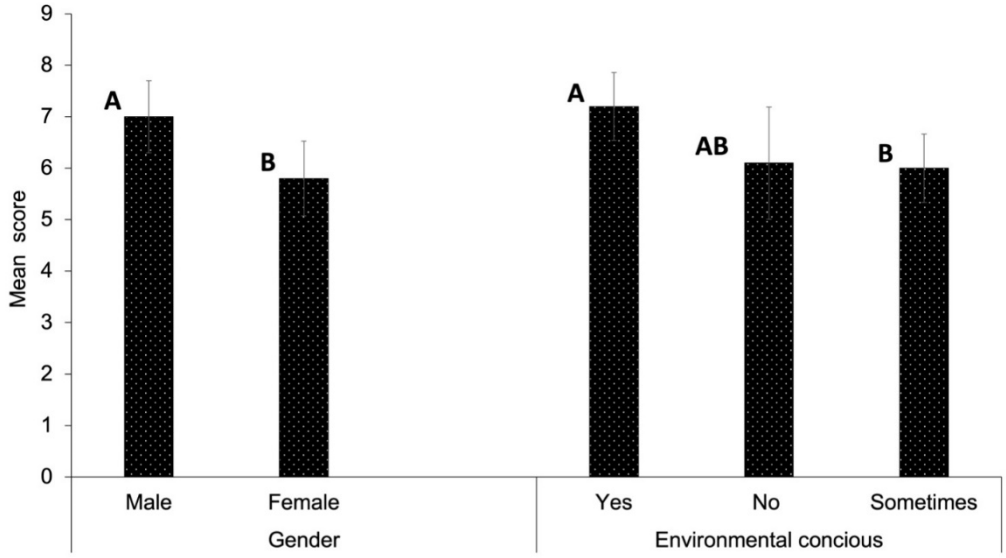

Figure 8. Liking of the use of AW for food packages based on participants' gender and environmental consciousness. Different letters indicate a significant difference within gender and environmental consciousness at $p \leq 0.05$. Use of a nine-point hedonic scale from Dislike extremely (1) to Like extremely (9).

3.5. Consumers' Perception of the Effect of Packaging Containing AW on Food Shelf Life and Safety

Participants' perception of the effect of packaging produced with AW on the shelf life and safety of packaged food was assessed using bread as a food model. The results are presented in Table 4.

Table 4. Participants' perception of the effect of packaging containing AW on the shelf life and safety of food (n = 86).

Variables	Responses (%)			
	Decreases	No Effect	Increases	Do not Know
Shelf life	12.8	25.6	11.6	50.0
Safety	8.1	38.4	8.1	45.3

Approximately 50% of the survey panelists selected "I don't know" for both shelf life and safety. Therefore, approximately half of the survey participants were unsure if the new packaging would spark an effect on either the quality or the safety of the packaged food product. The second highest response was "No effect" for both shelf life (26% of participants) and safety (38% of participants). Approximately the same number of participants (~80%) responded from "Neither like not Dislike" to "Like extremely" when asked about their liking of the material (Section 3.4). This indicates that the survey participants liked the novel material without knowing much about its performance, even after rating performance as more important than the impact of packaging on the environment. The groups within population characteristics did not differ in their perception of the effect of packaging produced with AW on the shelf life and safety of packaged food. The above findings show that participants, regardless of their environmental consciousness, exhibit limited knowledge of what this novel packaging is all about, and thus, what possible effects it can have on the packaged food product. Therefore, it is crucial to educate consumers about the benefits of using AW-based packaging in terms of the food shelf-life extension

and safety to help boost its acceptance within the market. Furthermore, education will help consumers to make packaging choices based on informed decisions regarding the effect of this novel packaging on the food shelf-life extension and safety.

The literature shows contradictions about the influence of environmentally friendly packaging on consumers' perceived product quality. Magnier et al. [42] reported that their food products under study (coffee, chocolate, and raisins) were perceived to be of better quality when the packaging looked more sustainable (recycled cardboard look), while Magnier and Crié [36] found that some French consumers have evoked the idea that ecological packaging might not protect the product as well as conventional packaging. Our study shows a different consumer perception of packaging containing AW since the responses of the bulk of participants were "I don't know" or "No effect". The literature also shows how Turkish consumer perception toward the effect of innovative food packaging on food shelf life depends on consumers favoring innovative packaging for food or not [47]. This finding is supported by our results. A Likert score of 2.8 (slightly important) was obtained when consumers were asked about the importance of packaging containing AW as new packaging.

3.6. Purchase Frequency of Different Food Categories in Environmentally Friendly Packaging

Prior to determining participants' purchase intent of food in the novel packaging, their purchase frequency of 15 different food categories when these were packaged in environmentally friendly packaging was recorded (Figure 9) for comparison purposes. Participants' uppermost purchase frequency response was "sometimes" for most food categories. The food category that topped this response was "confectionary", with 43% of the participants. For the purchase frequency response "most of the time," fruits and vegetables had the highest frequency (43% of the participants). In agreement, Koutsimanis et al. [13] reported that US consumers significantly ($p \leq 0.05$) prefer bio-based materials over petroleum-based ones for packaging fresh sweet cherries. The largest responses for "all the time" were for the food categories meats and eggs (approximately 20% of the participants for each food category). This could be due to the use of paper to package meats (butcher paper) and eggs (pulp egg cartons). The largest responses for "never" were for the food categories sweeteners and fats (approximately 27% and 24% of the participants, respectively). These results show that the survey participants purchase more natural and healthier food products, like fruits, meats, and eggs, in environmentally friendly packaging compared with food products that are less healthy like fats and sweeteners. This can be explained by the fact that environmentally friendly packaging is associated with healthier and organic food. Lindh et al. [48] reported that Swedish consumers of organic food consider the effect of the packaging material on the environment more than Swedish consumers of non-organic food.

There were significant differences among the purchase percentage responses based on the environmental consciousness of the participants ($p \leq 0.05$) for most of the food categories under study (bakery products, meats, fish/fish products, cereals derived from grains and others, fruits and veggies, dairy products, fats and oils, sweeteners including honey, confectionary, and prepared foods). The participants who declared themselves as environmentally conscious reported buying more groceries in environmentally friendly packaging than the participants who declared themselves as maybe/sometimes environmentally conscious. This is because consumer's attitudes toward the environment have a significant impact on the purchase of food in environmentally friendly packaging [25,40]. This shows the importance of educating consumers to increase the purchase of food in environmentally friendly packaging, which would contribute to reducing the impact of packaging on the environment.

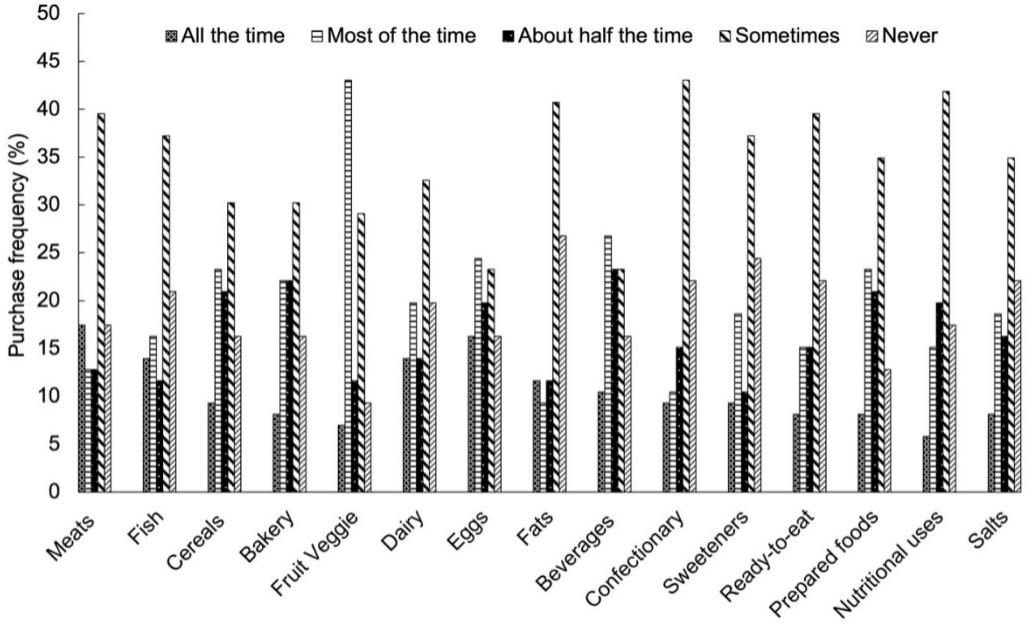

Figure 9. Purchase frequency of food categories in environmentally friendly packaging. Use of a five-point purchase frequency Likert scale ranging from All the time (1) to Never (5).

Three out of the fifteen food categories under study had different purchase frequencies caused by interactions between demographic and psychographic characteristics. The environmentally conscious participants aged 25 to 35 reported more often purchasing both dairy products and fats in environmentally friendly packaging during shopping than the participants of the same age group who declared themselves as sometimes environmentally conscious (p = 0.0001 and p = 0.0006, respectively) (Figure 10a). This is supported by the fact that US consumers who care about the environment prefer returnable glass milk bottles over paperboard gable-top packaging and plastic jugs because of the perception that returnable bottles are more helpful for the environment [23]. It is worth noting that the younger participants in this study (up to 35 years old) who identified themselves as not environmentally conscious contradicted themselves. This group selected their purchase frequency of dairy products and fats in environmentally friendly packaging as high by rating between "All of the time" and "About half the time." (Figure 10a). In contrast, the participants who identified themselves as sometimes environmentally conscious, regardless of their age group, selected their purchase frequency of dairy products and fats in environmentally friendly packaging as "sometimes", showing consistency between identification and way to pursue. Another two-way interaction showed that female participants who identified themselves as sometimes environmentally conscious purchased less fish products in environmentally friendly packaging during shopping than female participants who declared themselves as environmentally conscious (p = 0.0021; Figure 10b). This finding also shows consistency between identification and way to pursue.

3.7. Purchase Intent of Bread in Packaging Containing AW

After determining the purchase frequency of several food categories in environmentally friendly packaging, panelists were asked to indicate their purchase intent of bread in packaging containing AW. The results are presented in Figure 11. Approximately half of the participants selected either "moderately likely" (34%) or "extremely likely" (13%) when they were asked how likely they were to purchase bread in packaging containing AW. Furthermore, 17% of the participants reported that they were "slightly likely" to make the purchase. The Likert score was 5.2 out of 7 (slightly likely) when considering all the participants' responses. The consumers' willingness to purchase bread packaged in the new material aligned with the participants' liking of the use of AW for food packaging

(like slightly; Section 3.4). It is most likely that participants were willing to purchase food in the novel packaging due to the importance of the environmentally friendly aspects attached to it ("reduction", "waste management", "greener packaging", (Section 3.3)) since its performance in terms of food quality and safety was unknown (Section 3.5). Participants' willingness to purchase bread in packaging containing AW concurred, with "sometimes" being participants' uppermost purchase frequency response for most food categories, including bakery products in environmentally friendly packaging (Section 3.6). However, there may be other causes of the participants' responses.

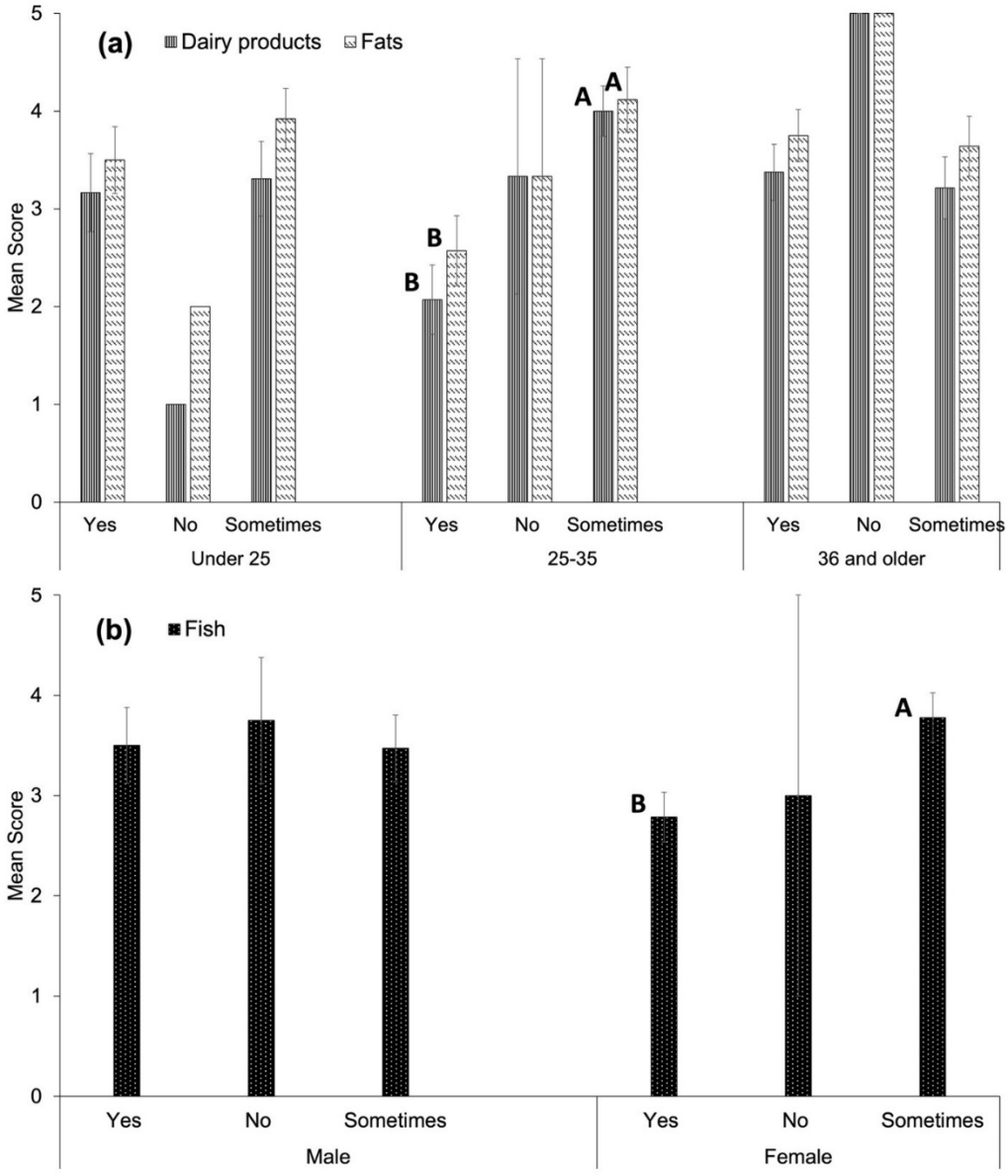

Figure 10. (**a**) Age*environmentally conscious interactions for the purchase frequency of both dairy products and fats in environmentally friendly packaging during shopping. (**b**) Gender*environmentally conscious interactions for the purchase frequency of fish products in environmentally friendly packaging during shopping. Different letters indicate a significant difference within environmentally conscious for the same gender or age at $p \leq 0.05$. Use of a 5-point frequency Likert scale from All the time (1) to Never (5).

Significant differences ($p \leq 0.05$) were observed based on the environmental consciousnesses of the participants. Participants who identified themselves as environmentally conscious reported that they were "moderately likely" to purchase bread in packaging produced with AW compared to participants who were sometimes environmentally conscious who reported they were "slightly likely" to make the purchase. This aligns with the higher purchase of bakery products in environmentally friendly packaging by the participants who identified themselves as environmentally conscious (Section 3.6). The above indicates that packaging containing AW would have a niche market since the novel material would be accepted by a significant number of consumers, specifically those who are environmentally conscious. However, the expense of manufacturing, which must be investigated, industry resistance to the implementation of new technologies, and merchants' unwillingness to consider package modifications are potential barriers to consumers using this packaging. Koenig-Lewis et al. [49] also found that consumers' environmental concerns strongly influence their intention to purchase food (specifically beverages) when packaged in a plant-based material.

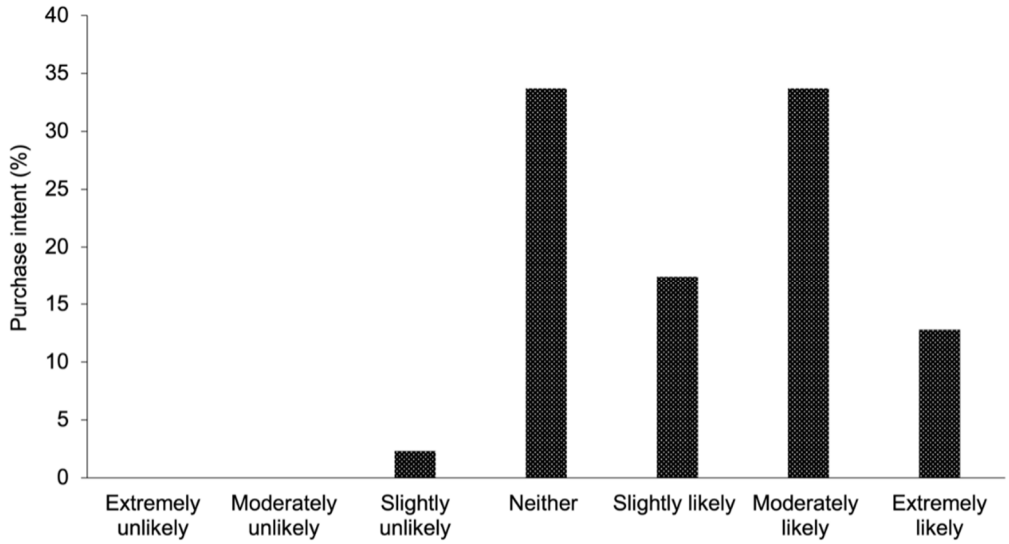

Figure 11. Purchase intent of bread in packaging containing AW. Use of a 7-point purchase intent Likert scale ranging from Extremely unlikely (1) to Extremely likely (7).

The Trivium Packaging report conveys that consumers in general are in favor of sustainable packaging for food (80% of 15,000 responses located in Europe and the Americas), although cost plays a key role in the sale of food in environmentally friendly packaging [45]. This report also reveals that 86% of the participants under the age of 45 are willing to pay more for sustainable packaging. In contrast, Otto et al. [50] reported that the Price Waterhouse Coopers GmbH found that 77% of German consumers are not willing to pay more for environmentally friendly packaging for food. It is also worth noting differences in consumer perceptions concerning the cost of environmentally friendly packaging resulting from consumer location. Scott and Vigar-Ellis [41] reported that approximately 51% of the South African consumers believe that environmentally friendly packaging would save them money, while Magnier and Crié [36] found that French consumers associate this form of packaging with an increase in price. The discrepancy could be due to the location of the participants since the promotion and implementation of environmentally responsible practices by authorities or industry are limited in emerging compared to high-income countries. Besides cross-cultural differences, demographics, and knowledge about the environmental effects of packaging, other factors that influence consumers' decisions to purchase food in environmentally friendly packaging include consumer attitudes, visual designs, functionality, and affordability [40].

Bread, the food model used in this study, is significantly wasted in many countries. For example, the Polish bakery and confectionary industry reported the loss of 2.63% in weight of the products manufactured in 2018 [51]. Brancoli et al. [52] reported a bread wastage of 80,410 tons/year in Sweden in 2019, with this being concentrated at households and in retail. An estimated 32% of all bread purchased is wasted in English households [53]. Hence, the impact of the bread supply chain on the environment has attracted growing attention. Packaging is an alternative to lessen the environmental impact resulting from the greenhouse gas (GHG) emissions caused by bread waste. This is because the impact of bread packaging on the total GHG emissions is about half of the impact of the wasted bread [54] and packaging can reduce bread waste by extending its shelf life. Nonetheless, problems with the way bread is currently packaged at various stages of the supply chain have been documented. These problems include the use of materials that do little to preserve bread's freshness at the household level [54] and packaging that becomes damaged during storage and transit [51]. Certain countries need to modify the packaging used to sell bread in order to extend its shelf life and reduce bread waste [54–56]. Consumers' willingness to purchase bread packaged in the new material, along with its suitable properties for bread freshness maintenance [10], shows the potential of the new packaging to reduce food waste if used to commercialize bread. Therefore, packaging containing AW as a plastic filler has major potential for lessening the environmental impact through the reduction of food waste, the up-cycling of agricultural waste, and the reduction of plastic use.

4. Conclusions

This is the first study that reports on consumers' behavior toward packaging containing AW as a plastic filler for food. This novel packaging should be well received by a fair number of consumers based on the 50+% "liking" responses for the use of AW for food packages and the 45% "moderately likely" and "extremely likely" responses for the purchase intent of bread in packaging containing AW. Participants were possibly willing to buy food in the novel packaging because they valued the environmental benefits associated with it ("reduction", "waste management", "greener packaging"), even though they were unsure of how it affected the quality and safety of the food compared to the same packaging produced without AW. The latter could be the reason why the acceptance of this novel packaging was not higher, since participants rated packaging performance as more important than the impact of packaging material on the environment. This was not specific to packaging containing AW but rather to environmentally friendly packaging in general, as indicated by the greater selection of "sometimes" for the purchase frequency of most food categories in environmentally friendly packaging. Participants who identified as being more environmentally conscious supported the use of AW for food packaging more and purchased a higher percentage of most food categories in environmentally friendly packaging. They valued "reduction" and the effects of the packaging material on the environment more than the participants who valued the environment less. Therefore, packaging choices that affect the environment depend on consumer mindset, and consequently, educating consumer could contribute to reducing the impact of packaging on the environment and to boosting the acceptance of packaging containing AW within the market. Besides mindset, participants gender and age make a difference as well. Furthermore, two-way interactions between age and environmentally conscious and gender and environmentally conscious show further splits of the population. While this study presents limitations (one type of AW, one food product, and one state in the US), it significantly contributes to the literature since there is no information on this topic published elsewhere. Some of these limitations were impossible to avoid since they resulted from showing the packaged food to the survey participants to gather more reliable data and consumer panels' optimal size ranges between 75 and 100. Possible limitations of the use of this packaging by consumers include cost, if its production increases cost, which still needs to be investigated, technology adaptation and implementation by industry, and retailers not open to packaging changes. Notably, after several years of storage, the packaging material utilized to create the packaging

that was shown to the panelists has not changed, demonstrating its durability over time. This is an exploratory study since studies that include different AWs, food products, and geographic locations should be performed in the future for a better understanding of consumers' awareness, liking, perception, and purchase intent toward packaging containing AW for food.

Author Contributions: Conceptualization, E.A., J.F. and S.C.; methodology, E.A., J.F. and K.F.; validation, K.F. and J.F.; formal analysis, S.S., K.F., J.F. and E.A.; investigation, K.F., J.F. and E.A.; resources, E.A., S.C. and L.M.M.; writing—original draft preparation, K.F. and E.A.; writing—review and editing, K.F., E.A., L.M.M. and S.C.; visualization, E.A. and K.F.; supervision, E.A.; project administration, E.A.; funding acquisition, E.A., L.M.M. and S.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the MSU Center for Packaging Innovation and Sustainability, the MSU Summer Research Opportunities Program and Graduate School, and the US Department of Agriculture (Hatch project 1007253).

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki, and it was approved by the Institutional Review Board of Michigan State University (protocol code STUDY00002025 and date of approval 1/23/2019).

Informed Consent Statement: Signed informed consent was obtained from all the subjects involved in the study.

Data Availability Statement: The data used to support the findings of this study may be made available by the corresponding author upon request.

Acknowledgments: The authors thank the MSU Center for Packaging Innovation and Sustainability for providing financial support. The authors thank the MSU CANR Statistical Consulting Center for providing statistical analysis support. Eva Almenar thanks the Hatch project 1007253 from the US Department of Agriculture for providing financial support. Korey Fennell thanks the MSU Summer Research Opportunities Program and Graduate School for providing financial support.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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