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RESEARCH ARTICLE

Perfect apples or sustainable production?—Consumer perspectives from Germany

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Abstract

In recent years, environmental problems, such as resource depletion and biodiversity loss, have come to the forefront of society's attention. Consumption of fruits and vegetables from extensive production systems could decrease food loss and increase biodiversity and more sustainable resource use. However, fruits and vegetables from extensive production systems are not always of perfect external quality, and hence, rejected by consumers. To increase acceptance of imperfect fruits, this study aims to better understand consumers' perceptions of different levels of imperfections, using apples as an example. An online survey with 842 German consumers investigated associations, important apple-buying criteria, organic apple consumption, socio-demographics, and willingness to pay (WTP) for apples with different levels of imperfection. The latter is investigated via contingent valuation. A multiple linear regression was calculated for each level of imperfection. Results show that consumers' WTP for apples differed depending on the level of external imperfections. The majority of consumers accepted slightly imperfect apples; a noticeable share would even buy them at the same price as flawless apples. Apples with heavy imperfections were mainly accepted by consumers who had sustainable buying criteria. To increase acceptance, it is important to tell consumers that their food choice can make an impact on how apples are produced, that imperfect apples come from more sustainable production systems and are of perfect internal quality. And finally, it is important to give specific advice that buying these apples can help to increase sustainable resource use and biodiversity.

1 | INTRODUCTION

In recent years, societies' awareness for environmental problems, such as species extinction and resource depletion, has increased, as has the demand for sustainably produced food (Schaffner et al., 2015; Tulloch et al., 2021). A growing consumer segment is willing to pay higher prices for products from sustainable production systems, such as extensive or organic cultivation (Petersen et al., 2021; Pouta et al., 2021; Zander & Feucht, 2018). In these sustainable production

systems, skin defects caused by pests and fungi can be more difficult to control than in conventional cultivation due to the minimal use of plant protection measures (Holb et al., 2012). This leads to a potentially higher share of imperfect fruits. Marketing these imperfect fruits from sustainable production systems could, hence, contribute to expanding sustainable resource use and reduce food losses.

However, due to marketing standards (EU, 2019; UNECE, 2020) and retail market power (Herzberg et al., 2022), there is a strong focus on external quality aspects throughout the value chain. Cosmetic

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standards push producers to a high use of pesticides and fertilizers in order to produce the demanded perfect looking fruits and vegetables—at the expense of sustainable farming practices and biodiversity. Consequently, consumers encounter almost exclusively flawless fruits and vegetables in the market place. This leads to consumers who reject imperfect fruits and vegetables (e.g., Cao & Miao, 2021; de Hooge et al., 2017; Kyriacou & Roupael, 2018; Pfeiffer et al., 2021; Tarancón et al., 2021), and to retailers who demand ever higher marketing standards (Herzberg et al., 2022). The development of alternative perspectives on quality for fresh fruits, for example, focussing more on internal quality aspects, that is taste, nutritional values and texture (Kyriacou & Roupael, 2018), as well as increasing the acceptance for visual imperfections for fruits and vegetables, is hampered. Hence, imperfect fruits and vegetables are not marketed and food loss and waste are increasing (Porter et al., 2018). As a solution, retailers could reduce their marketing standards, but will unlikely do so, as they compete with other retailers for the best external quality (Herzberg et al., 2022). Alternatively, consumers could change their behaviour towards choosing imperfect food; but so far, they have mostly not done so. It is therefore important to take a closer look at how consumers perceive these imperfect products, with which they are less familiar (Hartmann et al., 2021). The lack of awareness makes it difficult for consumers to assess the impact of their own actions on sustainable production systems.

Looking at the literature in more detail, many studies have shown that consumers generally value sustainably produced products (e.g., Di Vita et al., 2021; Smith et al., 2021), but have a low acceptance for imperfect fruits and vegetables (for an overview see Hartmann et al., 2021). Hence, the challenge remains to align the positive effects of sustainable or extensive production with high consumer expectations on external fruit quality and rejection of imperfections. Yet, only few studies have investigated the monetary value of imperfections, for example, consumers' willingness to pay (WTP) for imperfect products (Campos et al., 2022; Collart et al., 2022; Di Muro et al., 2016; Neubig et al., 2022; Yue et al., 2007).

Against this background, the goals of this study are to first, better understand consumers' perception of apples with different levels of external quality, second, to investigate consumers' WTP for different levels of external quality, and third, to identify what characterises consumers who show especially low or high WTP for imperfect apples. On this basis, recommendations are given regarding how to increase consumer acceptance of fruits with different levels of imperfect external appearance.

2 | STATE OF RESEARCH

2.1 | Consumers' perspectives on sustainable fruit consumption

Sustainable consumption needs sustainable food systems. Measures to improve sustainability within the food system are very diverse. Besides certified organic production, sustainability measures entail gentle soil cultivation (Ruggeri et al., 2020), protecting and providing

habitats for birds and wildlife, using agroforestry systems, reducing pesticide use and protecting bees through pollinator management (Gatti et al., 2022; Khai & Yabe, 2015, p. 4; Smith et al., 2021; Tu et al., 2021).

Consumers value products that have been produced in a sustainable way (Smith et al., 2021; Stampa et al., 2020). Focusing on fruit production measures, Tait et al. (2015) found that UK consumers value reduction of carbon emission the highest, followed by increased water use efficiency, waste or packaging reduction, and increased vitamin content. Looking at specific fruit products, Oh et al. (2015) have investigated bird pest management strategies in apple and grape production via a choice experiment. They found that consumers had a higher WTP for local production and natural bird pest management strategies, for example, falconry or installing nesting boxes for prey birds, compared to ammunition. Other studies have focused on different grape production methods. Consumers of high-quality Italian wines valued organic production methods higher than biodiversity-friendly production methods (Ruggeri et al., 2020). Only when biodiversity was explicitly promoted, wine consumers stated a higher WTP for medium-high- and low-priced wines, as has been found by Mazzocchi et al. (2019). When producing apples for cider, local and organic production generated the highest consumer WTP, followed by integrated pest management and 'supporting biodiversity restoration' (Smith et al., 2021, p. 1). Also, Di Vita et al. (2021) found that organically produced clementines are preferred over clementines from integrated farming systems.

Consumers value sustainability measures, but prefer established concepts such as local or organic production. This becomes clear by many studies reporting that consumers are willing to pay a price premium for products from organic or local production systems (e.g., Smith et al., 2021). One reason for the preference of these established concepts could be that consumers are more familiar with them. Indeed, de Boer and Aiking (2021) found that 40% of their sample had not heard of the term biodiversity before.

2.2 | Consumers' quality understanding of (imperfect) fruits

Consumers use cleanliness, freshness and price when evaluating fresh fruits (Petrescu et al., 2019). Cleanliness and freshness are related to external appearance. External appearance has different dimensions: shape, skin quality or external quality and colour. Apples with imperfect shape and colour are better tolerated than apples with imperfect skin or skin damages, such as bruises (Bolos et al., 2021; de Hooge et al., 2017). Yet, a perfectly shaped apple does not outweigh imperfect skin quality, as the latter impairs consumers' perception of beauty which has a negative inference on overall quality (Pfeiffer et al., 2021). Consumers associate deviations from perfect external appearance with lower sensory quality (van der Merwe et al., 2015), and less sweet or crisp taste (Normann et al., 2019). According to Jaeger, Antúnez, et al. (2018), imperfect apples are rejected and no longer purchased. These findings are supported by Tarancón et al. (2021), where consumers preferred waxed, shiny, and glossy mandarins.

Looking at the studies which have investigated willingness to buy or pay in relation to imperfect foods, willingness to buy is reduced when it comes to abnormally shaped food (Powell et al., 2019). Powell et al. (2019) investigated, amongst other products, abnormally shaped apples, oranges and citrus fruits in relation to consumers' disgust propensity and sensitivity. The authors found that high levels of disgust propensity and sensitivity decreased WTP for oddly shaped fruits. Also, Huang et al. (2020) have investigated citrus fruits, but focused on external appearance and size. Results from a choice experiment show that participants prefer citrus fruits with imperfect appearance the most when they come with a moderate size, freshness indicators, traceability certifications, and a discounted price (Huang et al., 2020). Collart et al. (2022) look at WTP for different levels of blemish in sweet potatoes and the influence of information on food waste due to the grocery store's food waste policy, and information on environmental impact of food waste. Consumers have a positive WTP for blemished sweet potatoes, yet it decreases with increasing levels of blemish. Informational messages related to the impacts of a store's food waste policy and environmental impacts of food waste are able to increase the demand for blemished sweet potatoes, especially if the messages were combined.

Finally, Yue et al. (2009) investigate external appearance of organic and conventional apples with different levels of blemishes via real and hypothetical auctions. Similar to Collart et al. (2022), WTP decreases with increasing levels of blemish. Thus, consumers prefer conventional apples if the organic apples are more than slightly blemished (Yue et al., 2009). Yet, the authors found a main challenge for products from sustainable production systems, such as the organic production system: consumers desire a sustainable fruit production, but are not willing to accept the natural consequence, that is fruits with external imperfections.

2.3 | Attitudes towards the environment and perception of food naturalness

Consumer attitudes towards the environment influence acceptance of imperfect fruits (Hartmann et al., 2021). Looking at apples from organic production, Yue et al. (2009) found that consumers with more positive attitudes towards the environment and organic food also have a higher WTP for organic apples compared to consumers with low environmental concern. For imperfect apples, Puteri et al. (2022) have shown in a mouse-tracking experiment that increased positive attitudes towards the environment lead to lower ambivalence and hence, to higher WTP. Also, Hartmann et al. (2021) found that high environmental awareness can influence imperfect food choice positively, especially when consumers also had high food waste awareness. However, there are also studies where even environmentally conscious consumers refuse to choose imperfect foods (Loebnitz et al., 2015). In order to explain WTP for apples with different levels of imperfection, this study also includes a scale on attitudes towards the environment.

From a consumers' perspective, local and organic production are closely linked to sustainability and food naturalness. In their review,

Román et al. (2017) classify consumers' definitions of natural foods into different categories: production, processing, and the final product. In the production category, natural products are defined as being from organic or local production (Román et al., 2017, p. 47), that is, a sustainable production system. Hence, consumers value naturalness as a positive food characteristic. Indeed, van Giesen and de Hooge (2019) and Wang et al. (2022) found that communicating the naturalness of imperfect fruits (via a label) can increase consumer WTP as much as a price discount can. In a recent field experiment with oddly shaped pears and cucumbers, de Hooge et al. (2022) found that sustainability and authenticity messages can not only increase the perceived similarity between suboptimal and optimal products, but also the actual sales. Qi et al. (2022) found that dual messages which emphasise the reduction of food waste as well as naturalness and authenticity of the imperfect products, increased WTP significantly (Qi et al., 2022). Meier et al. (2019) even went a step further and stated that consumers not only value naturalness, but have a 'natural-is-better' default belief, and hence, are willing to pay more for products which are labelled as being 'natural'.

Consumers show diverse preferences: they value natural products and products from sustainable production systems, indicating, for example, a positive WTP (Román et al., 2017; Smith et al., 2021). However, at the same time, they have a rather low acceptance or WTP for imperfect products (e.g., Collart et al., 2022) and those that are potentially more natural and come from sustainable production systems (Yue et al., 2009).

This study aims to expand the literature by focusing not on different types of imperfections in different fruits, but on different levels of visual imperfections in one type of fruit, namely, apples. Based on the above findings, sustainable consumption, external fruit quality, organic production, and food naturalness are important concepts that influence the consumption of (imperfect) fruits. The study's underlying assumptions are that external quality criteria are still important aspects to evaluate overall fruit quality, and that a high affinity towards sustainable consumption and familiarity with organic food goes along with a greater openness towards natural foods, such as imperfect apples. The question remains whether these assumptions are confirmed at different levels of imperfection.

3 | METHODS

The base of this study was a quantitative online survey which consisted of a questionnaire and a contingent valuation experiment, assessing respondents' WTP for apples with different levels of imperfections in Germany. Data on important apple-buying criteria, environmental attitudes, and socio-demographics were collected to explain respondents' WTP. In this study, apples with external imperfections are defined as being apples with cosmetic damages purely on the skin which do not impair inner quality or shelf-life. To assess WTP, pictures of three different apple qualities (Figure 1) were used, which correspond to different trade classes. Flawless apples are classed as class I apples and are found in all common shopping locations. Apples with slight imperfections correspond to class II apples

are also found in many shopping locations and can be of conventional or organic qualities. Apples with heavy imperfections are usually not found in the market.

As a qualitative pre-study, four focus group discussions (FGD) were conducted to get a first impression of consumers' perception of apples with imperfections. The information was then used in the online survey.

3.1 | Questionnaire

The questionnaire started with some introductory questions regarding important aspects when buying groceries, followed by the investigation of consumers' WTP via a contingent valuation method (CVM). The questionnaire continued with a 15-item battery on important apple-buying criteria, covering dimensions of sustainability, as well as external and internal quality. These criteria were derived from the FGD, and respondents rated each item on a 7-point Likert scale. The end points were labelled with '1—not important at all' and '7—very important'. The following items were investigated: shelf-life, no packaging, packaging without plastic, local production, organic production, promotion of biodiversity, variety, crispness, taste, shape, size, colour, flawless skin, no bruises and price. A principal component analysis with varimax rotation was done to see if these 15 items could be reduced to the three above-mentioned dimensions. Kaiser–Meyer–Olkin and Bartlett-Test, communalities, scree plot, and Kaiser-criterion (Eigen value >1) were used to check for suitability and quality of the factors. Cronbach's alpha was used to check the reliability of each extracted factor.

The associations with different external apple qualities were also derived from the pre-study. Participants were asked to allocate several characteristics to each of the apple qualities, using the pictures already presented in Figure 1. Each picture was assigned up to three characteristics from a list of 11 terms; the terms could be assigned twice via drag-and-drop. These terms were appetising, taste good, eat unpeeled, natural, unappetising, do not taste good, unnatural, not for guests, unhealthy, spoil quickly and for baking only.

Attitudes towards the environment were elicited by using the following four items adapted from different sources (BMU & UBA, 2019) with a 7-point scale labelled on end points '1—fully disagree' and '7—fully agree':

- 'For the sake of the environment, we should all be willing to cut back on our current standard of living.'
- 'Environmental protection is more important to me than economic growth.'
- 'I am concerned about the decline in biodiversity.'
- 'With my consumption behaviour, I can take responsibility for preserving our environment.'

These four statements were aggregated to build the scale 'importance of environment'. They were further checked for internal reliability (Cronbach's alpha = 0.802).

Lastly, the share of organic apple consumption, age, gender, income and education were elicited. These variables were used as independent variables in multiple linear regression analyses aiming to

explain participants' WTP for imperfect apples (Figure 2). Two different models were calculated with the same independent variables: one for slightly imperfect apples and one for heavily imperfect apples.

As mentioned above, WTP was investigated via the CVM. The CVM is a method to analyse consumers' WTP for different kinds of goods. It has been used for the valuation of GM-free, and sustainably or organically produced products (Brugarolas et al., 2010; Costa-Font et al., 2008; Loureiro & Bugbee, 2005; Zander & Feucht, 2018). Typical for CVM is that respondents are confronted with a valuation scenario in which they are directly asked for their WTP. Due to its hypothetical valuation situation, the CVM was sometimes criticised for overestimating WTP. However, it has been shown that the overestimation of WTP is lower compared to other methods in the case of private low-involvement goods, such as food (Grunert et al., 2009; Zander & Feucht, 2018). Thus, CVM represents a valid and efficient method for analysing WTP for private goods.

In this study, the following CVM scenario was established: Participants were first asked where they usually purchase dessert apples and how much they usually pay for one kilogramme of them. This price served as a 'personal' reference price for the respondents to ease into the idea of purchasing apples. Subsequently, three pictures were shown with apples of different external qualities. These were flawless apples, apples with slight imperfections and apples with heavy imperfections. The participants indicated their WTP for the apples in the respective picture in euros per kilogramme (Figure 3). To avoid systematic sequence effects, the order of the three pictures with the different external qualities was randomised.

WTP was investigated with an open question, and the analyses were done with relative numbers (%). This allowed us to explain the relative individual differences in WTP between the different trade classes and compensate for different price levels. For each level of imperfection, a linear regression model was calculated to explain respondents' WTP, using WTP for flawless apples as a reference price. For slightly imperfect apples, the dependent variable was the relative WTP (%) for slightly imperfect apples compared to flawless apples. For heavily imperfect apples, the dependent variable represented the relative WTP (%) of heavily imperfect apples in relation to flawless apples.

To exemplify this, the calculation of the dependent variable for heavily imperfect apples is shown:

$$\frac{\text{WTP for heavily imperfect apples} * 100}{\text{WTP for flawless apples}} = \text{Relative WTP for heavily imperfect apples}$$

As WTP was assessed via an open question, the absolute range for the stated hypothetical WTP for the three qualities was expected to be quite large. Hence, extreme values were checked for consistency within the three given WTP-values. When calculating the two regression models, the factor 'sustainable buying criteria important' and the scale 'importance of environment' were strongly correlated ($r_s = .578, p = < .001$). Hence, the scale 'importance of environment' was excluded from the regression models due to multicollinearity. Moreover, the respondents who had a stated WTP of zero for



FIGURE 1 Elstar apples with different external qualities as shown in questionnaire. *Left: flawless apples, middle: slight imperfections, right: heavy imperfections.*

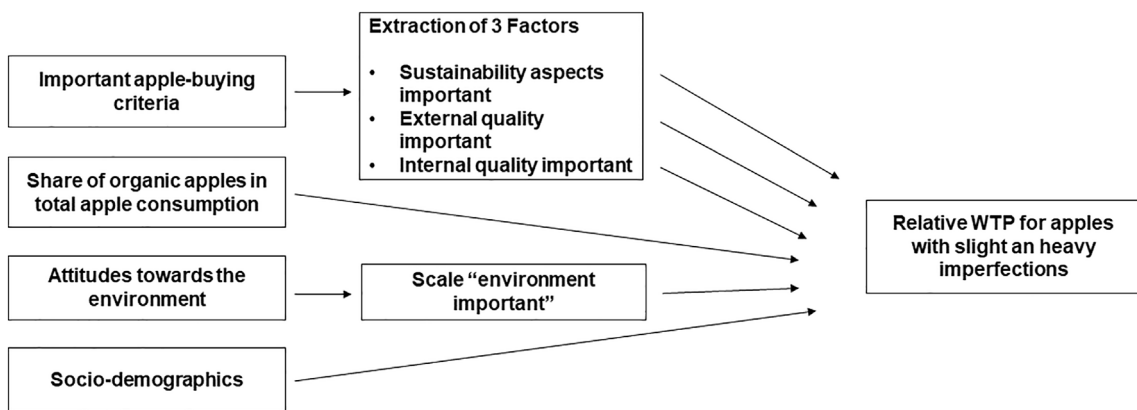


FIGURE 2 Overview over analytical framework.

Sie wurden gerade zum Einkauf von Tafel-Äpfeln gefragt. Sie können zwischen drei Apfelsortierungen wählen. Wieviel würden Sie jeweils bezahlen?

Bitte machen Sie Ihre Angabe im Format x,xx €/kg.



Ich würde €/kg für diese Äpfel zahlen.

Ich würde €/kg für diese Äpfel zahlen.

Ich würde €/kg für diese Äpfel zahlen.

FIGURE 3 Randomised pictures for assessment of WTP for apples as shown to the respondents. Caption above pictures read: ‘You have just been asked about purchasing fresh apples. You can choose between three apple categories. How much would you pay for each? Please use the format x.xx€/kg’. Captions below the pictures read ‘I would pay _____ €/kg for these apples’.

imperfect apples were excluded from the regression analyses: In model 1, seven respondents were excluded, in model 2, 56 respondents were excluded. For the statistical analysis, the software 'SPSS Statistics for Windows, version 26.0' (IBM Corp, 2019) was used.

3.2 | Data collection

The data was collected by a private market research agency from an online access panel in Germany from 22nd June to 26th June 2020. The following recruitment criteria and quotas were considered: participants had to be (co-)responsible for food purchases, and they had to consume apples and organic food at least occasionally. The distribution of age (18–75 years) and region was aimed to be as representative as possible for Germany, and a quota was set for gender relations (60%–70% women) since today, still, more women are primarily responsible for grocery shopping (Flagg et al., 2014). People working in agriculture or market research were excluded.

In total, 1034 participants completed the survey. To ensure data quality, several measures were taken. First, the response time served as a quality measure: only cases whose response time was at least half the median of the entire sample (7.73 min) were considered. Second, within the questionnaire, two statements with very similar content were formulated positively and negatively to check for consistency. If the participants rated the reversed formulated questions with the same value, for example, with 7 or 6 and 1 or 2, respectively, they were excluded. This procedure identified 139 respondents who gave identical or almost identical values of strong agreement or disagreement on the questions described. Third, there was an attention check towards the end of the survey where cases were screened out if they answered incorrectly. Finally, 842 participants remained in the sample (Table 1) and were considered for further calculations; response time was 17 min on average.

Respondents' age was largely representative for the German population. Only the 60–75 age group was slightly overrepresented compared to the German population (Destatis, 2020).

4 | RESULTS

Consumers' preferences for imperfect apples are influenced by several criteria which are presented in the following section: associations with apples of different external qualities, consumers' WTP for apples with different external qualities, and influencing factors on WTP, including important apple-buying criteria.

4.1 | Associations with apples of different external qualities

To investigate the perception of apples with different external qualities, the three pictures of apples (Figure 1), which the respondents had already assessed in the CVM, were shown. It becomes clear that respondents perceived flawless apples and apples with slight imperfections in many

TABLE 1 Summary statistics of the sample ($N = 842$).

Criterion	Characteristic	Share of sample
Gender	Female	61%
	Male	39%
Age	18–29 years	16%
	30–39 years	15%
	40–49 years	18%
	50–59 years	21%
	60–75 years	30%
Education	No graduation	0%
	Secondary school	18%
	High school	14%
	Completed apprenticeship	34%
	University or (technical) college degree	32%
	Other	1%
Monthly income	Less than 900€	6%
	900 to <1300€	8%
	1300 to <1500€	6%
	1500 to <2000€	11%
	2000 to <2600€	18%
	2600 to <3600€	22%
	3600 to <5000€	20%
	5000€ and more	8%
Not specified	1%	

criteria to be very similar and clearly more positive than the apples with heavy imperfections. In particular, associations of apples being appetising, having a good taste, and 'can be eaten with skin' were very similar for flawless and slightly imperfect apples (Table 2). However, interestingly, flawless apples were clearly mentioned less often as natural and also less often as healthy compared to those with slight or heavy imperfections. Apples with heavy imperfections were mostly associated with being natural and only for baking rather than for guests, as they were also perceived as unappetising and quickly spoiling (Table 2).

4.2 | Willingness to pay

WTP is an important indicator of consumers' preferences for the three different apple qualities. On average, absolute WTP for flawless apples was the highest and decreased with increasing levels of imperfections. For slight imperfections, respondents were willing to pay only 10% less than for flawless apples. For apples with heavy imperfections, respondents' WTP was reduced by 33% (Table 3) compared to flawless apples. As expected, the range for the hypothetical WTP was large, but even extreme values were consistent within the three qualities and were, hence, not excluded.

Taking a closer look at the sample, as expected, the majority of participants paid less for imperfect than for flawless apples (Table 4).

Interestingly, almost half of the sample was willing to pay the same price or even more for slightly imperfect apples than for flawless apples (Table 4). For heavily imperfect apples, the majority of the sample would pay less than for flawless apples. Despite this, almost 20% of the sample would pay at least the same price for heavily imperfect apples as for flawless apples (Table 4). This shows that there is a noticeable share of respondents who perceive apples with slight imperfections to be equal to or even better than flawless apples.

4.3 | Influencing factors on relative WTP for imperfect apples

As mentioned in the methods section, two multiple linear regression models were calculated to further explain relative WTP for apples

TABLE 2 Associations with Elstar apples of different external qualities (N = 405).

Terms	Flawless apples	Slight imperfections	Heavy imperfections
Appetising	70%	47%	5%
Taste good	55%	52%	23%
Eat with skin (unpeeled)	49%	44%	11%
Natural	17%	52%	54%
Unnatural	16%	4%	3%
Unhealthy	11%	5%	3%
Do not taste good	6%	7%	7%
Not for guests	4%	6%	45%
Spoil quickly	4%	7%	32%
Only for baking	3%	13%	51%
Unappetising	1%	2%	26%

TABLE 3 Means of absolute and relative WTP for apples with different external qualities; range of absolute WTP (N = 842).

Qualities	Flawless	Slight imperfections	Heavy imperfections
Absolute mean (€/kg)	2.87	2.57	1.88
Relative WTP	100% (reference)	90%	66%
Range	0.00–9.99€	0.00–8.00€	0.00–7.00€

with different external qualities. Therefore, 15 important apple-buying criteria were reduced to three dimensions via a principal component analysis (Table 5).

Looking first at the individual buying criteria, taste was the most important aspect with a mean of 6.58. It became clear that for the majority, taste and firmness, packaging without plastic, as well as the origin (locally grown) were important aspects when buying apples. With the exception of the characteristic 'no bruises', visual characteristics seemed to be of secondary importance with means ranging between 4.61 and 3.57 (Table 5). Moving to the factor analysis, the principal component analysis revealed three factors (Table 5). The first factor was named 'sustainable buying criteria important' as all items related to either sustainable production or packing, for example, organic production, no plastic packaging. The second factor represented 'external quality buying criteria important' as the items referred to external attributes, for example, shape, size and colour. The third factor related to the 'internal quality buying criteria important' of an apple, for example, taste and crispness (Table 5). The aspects price, variety and shelf-life were excluded due to low communalities.

These three factors were then included in the two linear regression models, together with other independent variables: the share of organic apple consumption, age, gender, income and education.

Model 1 aims to explain relative WTP for apples with slight imperfections (Table 6, model 1). The variable 'high share of organic apples in total apple consumption' and the factor 'sustainable buying criteria important' had a positive and statistically significant influence on relative WTP for apples with slight imperfections. This suggests that respondents with higher organic consumption and sustainable buying criteria have a greater WTP for apples with slight imperfections. The factor 'external quality buying criteria important' had the largest statistically significant and negative influence (beta = $-.213$) on relative WTP within the model, indicating that if shape, colour, size, and a flawless skin with no bruises were important, respondents were less willing to pay for apples with slight imperfections (Table 6, model 1). All other independent variables had a low and non-significant influence on relative WTP. For this model, the adjusted R^2 is only .079 (Table 6, model 1). This is due to generally few differences in WTP between flawless and slightly imperfect apples and the fact that almost half of the sample was willing to pay the same price for slightly imperfect apples as for flawless apples.

The model for heavily imperfect apples (Table 6, model 2) explained 17% of the variance, also reflecting the differences in absolute WTP. Age and gender showed a positive and statistically significant influence on relative WTP. This implies that older and female

Apple quality	WTP > 100%	WTP \approx 100% ($\hat{=}$ flawless)	WTP < 100%
Slight imperfections			
Share of respondents	8%	40%	52%
\emptyset WTP	134% (+34%)	100%	77% (-23%)
Heavy imperfections			
Share of respondents	5%	13%	82%
\emptyset WTP	141% (+41%)	100%	62% (-38%)

TABLE 4 Share of respondents with willingness to pay (WTP) > 100%, WTP \approx 100%, and WTP < 100% compared to flawless apples (N = 842).

TABLE 5 Summary of properties and factor loadings for a varimax-rotated three-factor solution after principal component analysis; mean of items from 7-point scale ($N = 842$).

Items	Factor loadings			Communality	Mean
	Sustainable buying criteria important	External quality buying criteria important	Internal quality buying criteria important		
Packaging without plastic	0.799			0.670	5.67
Organic production	0.792			0.631	5.24
Local production	0.791			0.632	5.57
No packaging	0.776			0.613	5.44
Promotion of biodiversity	0.729			0.532	5.06
Shape		0.852		0.773	3.57
Size		0.772		0.598	3.97
Flawless skin		0.728		0.629	4.12
Colour		0.718		0.568	4.61
No bruises		0.527	0.498	0.557	5.16
Taste			0.792	0.665	6.58
Crispness/firmness			0.730	0.586	5.84
Shelf-life	Excluded from factor analysis due to low communalities			0.332	5.30
Variety				0.293	5.18
Price				0.214	4.94
Eigen value	3.225	2.985	1.204		
Total explained variance (%)	26.9	24.9	10.0		
Cronbach's alpha	0.839	0.803	0.497		

TABLE 6 Influences on relative willingness to pay (WTP) for apples with slight (model 1) and heavy imperfections (model 2; multiple linear regression).

Independent variables	Model 1: Slight imperfections ^a			Model 2: Heavy imperfections ^b		
	Standard coefficient beta	Standard error	Significance	Standard coefficient beta	Standard error	Significance
(Constant)		3535	0.000		7.943	0.000*
Age (metric)	0.028	0.047	0.428	0.168	0.068	0.000*
Gender (0 = m, 1 = f)	0.022	1452	0.527	0.070	2.101	0.028*
Net income	0.028	0.348	0.412	0.040	0.503	0.210
Education 9–10 years ^c	−0.049	2056	0.200	−0.032	2.960	0.374
Education 12–13 years ^c	−0.018	1564	0.635	−0.058	2.261	0.100
Share of organic apple consumption >61% ^d	0.111	1641	0.002*	0.089	2.374	0.008*
Sustainable buying criteria important	0.078	0.756	0.034*	0.154	1.306	0.000*
External quality buying criteria important	−0.213	0.711	0.000*	−0.240	1.045	0.000*
Internal quality buying criteria important	−0.061	0.705	0.075	−0.121	1.018	0.000*

^aModel 1: Dependent variable: relative willingness to pay (WTP) for apples with slight imperfections. Reference: flawless apples (WTP slight imperfections \times 100/WTP flawless). $F(9|826) = 8.963^*$, $R^2 = .089$, adjusted $R^2 = .079$. *Level of significance $p = .05$. $N = 835$.

^bModel 2: Dependent variable: relative WTP for apples with heavy imperfections. Reference: flawless apples (WTP heavy imperfections \times 100/WTP flawless). $F(9|774) = 19.093^*$, $R^2 = .182$, adjusted $R^2 = .172$. *Level of significance $p = .05$. $N = 783$.

^cReference education: University/diploma.

^dReference share of organic apple consumption: <60%.

respondents had a higher relative WTP for apples with heavy imperfections, as had respondents with a high share of organic apples in total apple consumption (Table 6, model 2).

However, quality and sustainability criteria explained most of the model's variance. The factors 'external quality buying criteria important' and 'internal quality buying criteria important' had a negative

and statistically significant influence, whereby 'external quality buying criteria important' had the biggest influence ($\beta = -.240$) throughout the model. Different from model 1, the factor 'sustainable buying criteria important' had a positive and statistically significant influence on relative WTP for apples with heavy imperfections ($\beta = .154$). This indicates that if sustainable buying criteria were important, respondents had a higher relative WTP for apples with heavy imperfections (Table 6, model 2).

5 | DISCUSSION

Looking at consumers' general apple quality perceptions, internal quality, such as taste and firmness, as well as local production and packaging without plastic were the most important aspects when buying apples; price was less important. The latter is partly different from findings by Petrescu et al. (2019), who stated that cleanliness, freshness, and price were most important cues when evaluating fresh fruits. Visual aspects such as shape, colour, size and flawless skin were generally less important aspects than expected.

5.1 | Apples with slight imperfections—Consumers' associations and WTP

From the literature it is known that from a perfect visual appearance, consumers infer good internal quality and vice versa (Normann et al., 2019; van der Merwe et al., 2015). This became clear when looking at respondents' associations of different external apple qualities. When external appearance was not or only slightly impaired, as was the case for flawless and slightly imperfect apples, both were associated with a good internal quality, for example, good taste and an appetising appearance. This also indicates that there is a high tolerance for apples with only slight imperfections. Also, Pfeiffer et al. (2021) found that consumers perceive something that is 'beautiful' as something that is 'good', inferring that a perfectly shaped apple is also tastier, healthier and of better quality than a deformed one. Slightly imperfect apples were also associated with being more natural than flawless apples. This was reflected in the regression model: a high share of organic apples had a positive and statistically significant influence on relative WTP for imperfect apples. According to Román et al. (2017), this could reflect a preference for natural foods as consumers understand organic food production as an indicator for food naturalness.

Corroborating the findings related to respondents' associations, almost half of the respondents showed a high acceptance for apples with slight imperfections, being willing to pay the same price, and on average only 10% less than for flawless apples. Taking a closer look, the regression model revealed that respondents with a high share of organic apple consumption and for whom sustainable buying criteria were important, had a higher WTP for slight imperfections. This underlines the preference for natural apples, as was found within the associations with slight imperfections. 'External quality buying criteria important' had the strongest and most negative influence on

respondents' relative WTP, but also 'internal quality buying criteria important' had a negative influence. This could be explained by consumers reasoning that internal or sensory quality is impaired when external appearance is not perfect (van der Merwe et al., 2015). Moreover, this shows that consumers for whom external quality buying criteria were very important have a high sensitivity to already slight imperfections and hence, a reduced WTP. Also, Yue et al. (2007, p. 1369) found that even 'relatively low amounts of blotches are still "too many"' and can hence reduce WTP for apples with slight imperfections.

5.2 | Apples with heavy imperfections—Consumers' associations and WTP

Looking at associations with heavily imperfect apples, respondents' associations suggested a low internal quality, for example, being unappetising, spoiling quickly and suited only for baking. Similarly, Normann et al. (2019) and Jaeger, Antúnez, et al. (2018) found that perceptions of imperfect external appearance negatively influence the hedonic expectations, for example, taste. Similar to slightly imperfect apples, also heavily imperfect apples were associated with being more natural than flawless apples. Perceived naturalness has mostly a positive connotation, as consumers are known to have a 'natural-is-better-bias', believing that natural products are better by default than unnatural products (Meier et al., 2019). This positive connotation of naturalness could be an explanation as to why almost 20% of respondents would pay the same price for heavy imperfections than for flawless apples.

However, WTP decreased when going from flawless to heavily imperfect apples, reflecting respondents' overall quality perceptions: relative WTP for heavy imperfections was reduced by 33% compared to flawless apples. This is similar to findings by Puteri et al. (2022), who investigated consumers WTP for suboptimal organic apples, which was 25% reduced compared to the perfect looking option. Regarding the naturalness of heavily imperfect apples, the regression model supports this finding by revealing a positive and statistically significant relative WTP if respondents have a high share of organic apples in total apple consumption. Besides consumers positive association with natural products (Meier et al., 2019), another explanation for respondents' higher WTP could be that organic consumers generally have a higher WTP (Olbrich et al., 2015). Hence, emphasising the naturalness of these apples, could help to increase further acceptance and reduce the needed price discount (van Giesen & de Hooge, 2019; Wang et al., 2022).

The influences of external and internal quality buying criteria for heavily imperfect apples are stronger than for slightly imperfect apples. Heavily imperfect apples are possibly perceived to lack internal and external quality which is in line with Petrescu et al. (2019), who found that freshness, taste and appearance are the most important cues when evaluating food quality. If these are lacking, the perceived internal quality decreases. Here, disgust may also come into play, as Powell et al. (2019) found that when consumers had high level of disgust propensity and sensitivity, WTP for atypically shaped fruits and vegetables decreased. Another reason for respondents' lower

WTP for heavily imperfect apples could be the direct comparison to flawless apples when asked for WTP. Here, Jaeger, Machín, et al. (2018) found that imperfect apples were rarely chosen at the point of purchase, especially when offered next to perfect looking apples as consumers cannot see any sustainability aspect or benefit when choosing imperfect apples. This suggests that increasing acceptance for heavily imperfect apples is more challenging and will need a reduced price.

If consumers had sustainable buying criteria, they had a higher relative WTP for heavily imperfect apples. On the one hand, this implies that sustainability aspects may compensate for the decreased functional attributes of heavily imperfect apples, that is, visual imperfections and potential need for peeling. On the other hand, the sustainability aspects mentioned in this study—no (plastic) packaging, local or organic production—resemble the cues consumers use to evaluate environmental impact of food, as was found by Petrescu et al. (2019). This suggests that consumers assume an environmentally friendly impact with accepting heavily imperfect apples.

Concerning the socio-demographic variables, the positive and significant influence of age and gender on relative WTP for heavily imperfect apples is not always corroborated by other studies, as can be seen in the review by Hartmann et al. (2021); for example, van Giesen and de Hooge (2019) found a negative influence of age for purchase intention of oddly shaped apples, and also women were found to be more reluctant to purchase suboptimal foods (de Hooge et al., 2017).

5.3 | Limitations

As in every study, the authors were faced with trade-offs in their study design. As for the pictures which served as a base for the CVM, they were aimed at being most realistic, related to the current quality categories in the supermarket, showing several apples with different types of imperfections. However, the shown categories appear in different frequencies in Germany: class II apples with slight imperfections are regularly found in grocery stores and are of conventional and organic quality. Heavily imperfect apples are usually not marketed regularly. Only recently, some retailers started campaigns for marketing fruits and vegetables with imperfect shape or skin deficiencies at a reduced price, such as ‘weather apples’ from the discounter Aldi, or ‘Organic heroes’ from the discounter Penny. Hence, consumers may have previously encountered more slightly imperfect than heavily imperfect apples in the market. This could have created some bias, as consumers are more familiar with slight imperfections. In a real market setting, consumers usually do not encounter all three apple categories next to each other, so that this study's setting is somewhat artificial. This might have influenced the results. Respondents' WTP for heavily imperfect apples could have decreased even more, as the imperfections look worse when presented next to flawless apples. Besides the design of the study, the decision to show only a red-coloured variety of apples could have decreased WTP from consumers who prefer e.g. green or yellow apples. Assessing consumer preferences and stated WTP comes with the issue of the attitude-behaviour gap, where respondents' answers deviate from their behaviour when asked

for actions (Schäufele & Janssen, 2021). The results in this contribution compare different levels of WTP with relative numbers, and they are hence, not affected by the attitude-behaviour gap. However, one should be cautious about deriving absolute WTP-values for real sales situations from these results.

6 | CONCLUSIONS

This study is aimed at better understanding consumers' preferences for apples with different external qualities in order to increase acceptance for apples with external imperfections. It contributes to the scientific knowledge of consumer behaviour towards visually imperfect fruits, showing that slight imperfections are quite well accepted. Regarding theoretical implications for slight imperfections, the ‘naturalness’ of apples seems to be merely positively connotated and outweigh the slight external imperfections, similar to the findings by (Cao & Miao, 2021). For heavy imperfections, the external quality perceptions are still often the most important criterion for consumer quality evaluation (Jaeger, Machín, et al., 2018), unless consumers are already quite aware of the environment and of sustainability criteria when doing grocery shopping. This is underlined by the study's results. For apples with slight imperfections, WTP is only reduced by 10%, and acceptance is high, except for respondents for whom external appearance is very important. That means the majority of consumers would buy slightly imperfect apples—and a noticeable share even at the same price as for flawless apples. This shows great potential for further marketing. As quality aspects are still important, communicating that internal quality is not impaired could potentially even increase acceptance. For apple producers, this is a great chance as they can move towards a more extensive and sustainable production, which increases biodiversity at possibly lower production costs. In order to accept apples with heavy imperfections, consumers need positive environmental attitudes and should appreciate sustainable apple-buying criteria. If sustainability is not very important, apples with heavy imperfections would need an average price discount of 33% to be bought.

Based on McAfee et al. (2019) and Schaffner et al. (2015), in order to increase the acceptance of imperfect apples, it is important to create awareness of the problem which should be customised to the consumer group, to create a learning opportunity, and to do it in an optimistic and solution-oriented way. Hence, communication of imperfections would need to be more substantial: telling consumers that their food choice can have an impact on how apples are produced, that imperfect apples come from more sustainable production systems and are of perfect internal quality, and finally, giving specific advice that buying these apples can help to increase sustainable resource use and biodiversity.

Although this can be costly, bringing consumers in contact with naturally imperfect products again also means to reconnect consumers with food production. This can initiate a much-needed shift throughout the entire value chain to appreciate other perspectives on quality than external factors (Kyriacou & Rouphael, 2018). The negative perception of external imperfections is rooted in socialisation as already children learn

to devalue imperfect products by replicating their parents behaviour (Makhal et al., 2020). Thus, besides educating adult consumers on the positive effect of purchasing imperfect apples, that is increasing sustainable production and biodiversity, it is worth also investing in future generations in order to establish valuation and preference for naturally imperfect products.

In this study, the focus was placed on the consumer perspective and the potential to increase their acceptance for imperfect apples. Nevertheless, retailers need to cooperate by listing imperfect apples and communicating the benefits of imperfections to consumers. Only then can consumers make responsible buying decisions and support more sustainable production systems. Further research could aim towards store tests to account for the attitude-behaviour gap of consumers and set a focus on how to communicate naturalness and perfect internal quality.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict 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.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

INFORMED CONSENT

Prior to participation, all respondents were informed that participation is voluntary, that the focus group discussions were audiotaped, and that the data would be evaluated anonymously and treated in accordance with data protection regulations. This was done via written informed consent.

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