The application of choice experiments in a study on consumer preference for agri-food products: A literature review

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Abstract: A choice experiment (CE) is a stated preference method to elicit the respondent's preference. The CE can predict consumer valuation for a hypothetical product's attributes. Many scholars have discussed the CE's design, analysis, reliability, and validity. Still, no scientific papers reviewed its application in agri-food studies in a broad spectrum, particularly in investigating food product categories and their attributes. Additionally, this review emphasises the technical aspects of CEs, such as the sample size, software, data analysis, and research implications. The result discovered that most CE studies are relevant to developed countries. Most reviewed studies observed wine and meat as objects in the CE studies, in the theme of health, food safety, origin, and sustainability. The future research trend was related to health benefits and natural ingredients. Thus, this review provides recommendations for future studies to explore consumer preference using CE in agri-food research.

Keywords: agri-food choice study; choice experiments application; consumer food preference; future research; systematic literature review

A choice experiment (CE) is a method used to investigate consumer preferences for market or non-market products developed by Louviere and Hensher (1983) and Louviere and Woodworth (1983). This approach adopts the random utility theory (McFadden 1974) and Lancaster's consumer theory (Lancaster 1966), stating that consumers do not obtain utilities from the product itself but from the contained attributes. Compared to other stated preference methods, such as the contingent valuation (CV), analytical hierarchy process (AHP), and conjoint analysis (CA), CE is more relevant to neoclassical economic theory standards. CE can set the data retrieval process as in a real market environment and can be used to discover the drivers of customer purchasing behaviour and to estimate the willingness to pay (WTP).

CE is enormously beneficial since it enables the inclusion of new items or features that do not exist in the actual world and for which no data exists. Also, CE can forecast the demand in certain circumstances and is particularly useful when data from current markets are unavailable. CE is a powerful technique for identifying the relative importance of various attributes and levels in consumer decision-making and calculating trade-offs between them. The respondents are presented with numerous alternatives, representing a combination of product attribute levels, then pick one choice based on their preference. However, if the respondents do not concur with all of the alternatives presented, they choose a trade-off option. Following the utility maximisation behavioural rule makes it possible to conclude that the customers' choice contains

features that maximise their utility. Researchers cannot observe the random component of utility; hence a systematic assessment technique is required (Louviere et al. 2010). Furthermore, as stated by Lancaster's theory (Lancaster 1966), products and services have a set of attributes. Thus, the systematic utility may be represented by attributes and their levels and the characteristics of the respondent.

Most CE studies in agri-food are related to the topic of new product development (Zhu et al. 2018; Wanyama et al. 2019), marketing strategies (Casini et al. 2016; Wu et al. 2017), and policy recommendations (De Marchi et al. 2019; Ballco et al. 2020). The food industry faces a market failure risk during a new product's launch process, as food innovation is frequently insufficient to meet customer satisfaction (Horvat et al. 2019; Guiné et al. 2020). Revealing consumer preference for a product's attributes is essential for stakeholders in strategic decision-making (Dawoud 2019). Furthermore, food policies are also at risk of being ineffective and are often improperly targeted (Guo et al. 2019).

Previous studies show significant differences in CE practice, ranging from the sample size to software, and data analysis (Cantillo et al. 2020; Sharma et al. 2020). Many scholars have discussed its design, analysis, reliability, and validity (Reed et al. 2020; Mariel et al. 2021). However, studies that review the pattern and resemblances of CE applications in order to investigate consumer preferences for agri-food products are still lacking. So far, the only initiative review was performed by Cantillo et al. (2020), which only focused on finfish. Compared to Cantillo et al. (2020), this review provides a broader view by including all agri-food products. Additional information in this review could be beneficial to the richness of the literature on CEs in agri-food products. Furthermore, the results of this review can be a reference for the use of CEs in food products for future research.

This review contributes to the scientific body of knowledge by offering an overview of the application of CEs to ascertain consumer preferences for agri-food products. This study has three objectives: *i*) to analyse the agri-food products categories and attributes used in CE consumer research, *ii*) to summarise the sample size, software and data analysis procedures used, and *iii*) to suggest future research directions. Specifically, this review seeks to determine which products and attributes have been extensively studied and which have not, indicating a potential area of research for upcoming studies.

This review adopts the definition of the systematic literature review proposed by Moher et al. (2009).

The systematic literature review is an analysis of the relevant research that employs systematic and explicit procedures to identify, pick, and critically appraise the relevant studies and analyse data from the included studies. Moreover, the systematic literature review developed a precise question and used specific methodologies to decide the data extraction and analysis.

MATERIAL AND METHODS

The systematic review was conducted from January to July 2021. The article collection is based on a targeted inquiry under the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol used for the data extraction approach (Moher et al. 2009). It is a strict protocol of identifying literature to ensure that the process is recorded and reproduced for validation and extended in the future (Koutsos et al. 2019; Snyder 2019). It includes several steps such as identification, screening, eligibility assessment, and interpretation of the findings (Khan et al. 2003).

Identification of the publications. We utilised several databases, namely ScienceDirect, ProQuest, Emerald Insight, Cambridge, JSTOR, CAB Direct, Springer, and EBSCO. All search results were then collected for screening and eligibility assessment on the titles and abstracts. We identified them in a sequential order based on inclusion criteria for keywords, titles, abstracts, and full-text assessment.

Screening and eligibility assessment. We conducted an advance search using the syntax keywords '(Choice Experiment OR Discrete Choice Experiment OR Choice-Based Conjoint) AND (Consumer Preference)' within every database. The function of the 'OR' operator is to partially display articles based on either keyword, while the 'AND' operator demonstrates the appropriate article containing both keywords. The 'OR' and 'AND' are common Booleans that used to combine keywords to improve the effectiveness of the search [Boolean are short phrases (AND, OR, NOT, or AND NOT) that are used in combination with keywords to integrate or exclude them from a search, resulting in more focused and productive results; this should reduce the time and effort by reducing the number of irrelevant results that must be screened before being discarded]. Despite the controversy over the terms CA and DCE (Discrete Choice Experiment) (Louviere et al. 2010), many studies indicate that there were no differences in the design or foundation theory used for the Choice-Based Conjoint (CBC) and DCE (Gensler et al. 2012; Lebeau et al. 2012; Lu et al. 2016; Nesselhauf et al. 2019).

We set inclusion-exclusion criteria in order to identify the appropriate articles and to narrow the search. We only included studies written in English and published in peer-reviewed journals between 2010 and 2020 that discussed consumer preferences, food research categories, and employed the CE approach. On the exclusion criteria, in addition to issuing articles that do not match the inclusion, we excluded articles that did not utilise the price as an attribute in the study, we excluded literature reviews, proceedings, book chapters and dissertations, as well as method comparison articles. Articles that matched the inclusion-exclusion criteria were exported as citations (RIS format). After removing any duplicates, we conducted a rapid qualitative assessment within every paper's title and abstract.

Data extraction. The extracted data were tabulated from each article that passed the full-text assessment stage. The first set of information included the author, title, period, and country. Then, we synthesised the data related to the food products and attributes. Next, we synthesised the number of attributes, the data analysis, and the implications. We performed a qualitative grouping on each synthesised piece of information in order to obtain more organised data. Finally, we analysed the extracted data for patterns and information gaps to formulate research recommendations for future studies.

RESULTS AND DISCUSSION

Search result. A total of 2 130 studies were exported. After a duplicate check, 2 110 articles were generated. Next, screening was carried out through the title and abstract by the inclusion-exclusion criteria which produced 194 articles. The next stage was the full-text assessment, where we eliminated 22 articles and found 172 eligible studies for the synthesis (Figure 1).

Figure 2 illustrates the number of CE studies from 2010 to 2021. Overall, there was an increasing trend in CE studies on consumers' agri-food preference in the last decade. The increased research is directly proportionate to the rising popularity of the CE approach, particularly for analysing customer preferences (Schlereth and Skiera 2017; Feuz et al. 2020; Wang et al. 2021). Additionally, since the experimental economics stream has spawned several Nobel prize winners over the last decade, CE studies have garnered great interest from the scientific community.

CE food studies are widely carried out in developed countries: Italy, China, and the US. This review found ten studies conducting cross-country research in Europe, two in Asia, one in Africa, and four conducted across the continents. The CE approach was introduced and has become popular in western countries; however, as a result of the present digital revolution, CE research is being conducted in an increasing number of developing nations. The primary challenge in conducting CE research is ensuring that respondents comprehend the questions in the choice sets. Therefore, researchers must convey the information regarding the attributes, levels, choice sets, and trade-off options before initiating the choice sets very clearly to the respondents.

Food products and attributes in the studies. This review highlights three food products as essential points of discussion: wine, beef, and food additives; with attributes related to health, food safety, the country of origin, and sustainability (Tables 1, 2). Wine is the most explored beverage product using CEs related to health risks and sustainability issues. Annunziata et al. (2019) investigated the effect of health risk warnings in the form of brain damage and accident risk on the preferences of the Y generation in the EU, and the results showed that they are careless about this warning. In the EU society as a whole, one in four young males and one in ten young women die from alcohol-related causes (European Parliament 2015). However, a recent study by Deroover et al. (2021) stated that today's consumers are very concerned about the health and are interested in healthier choices, so wine with a reduced alcohol content will become a trend in future studies. Indeed, since the COVID-19 pandemic started, the overall global public awareness on health has increased. The next issue is sustainability; a study by Tait et al. (2019) in California found that consumers are willing to pay a premium price for a wine's sustainability attributes. The research includes the management of biodiversity, water, by-products, energy, greenhouse gases, pests and diseases, and social responsibility attributes in the CE design. In contrast, a study conducted by Boncinelli et al. (2021) shows that, on average, Italian consumers do not prefer certified organic wine; only 19% of consumers are willing to buy organic wine. The market for sustainable wine is currently a niche market and is likely to remain that way, but the overall percentage of sustainable vineyards is high. A practical approach is to promote a perception within customers that they can make a significant contribution to environmental preservation by purchasing environmentally friendly products (Baiano 2021).

Beef is a popular meat product in CE studies. The country of origin is a steamy topic for meat products, but the trend only seemed to last until 2017. Re-
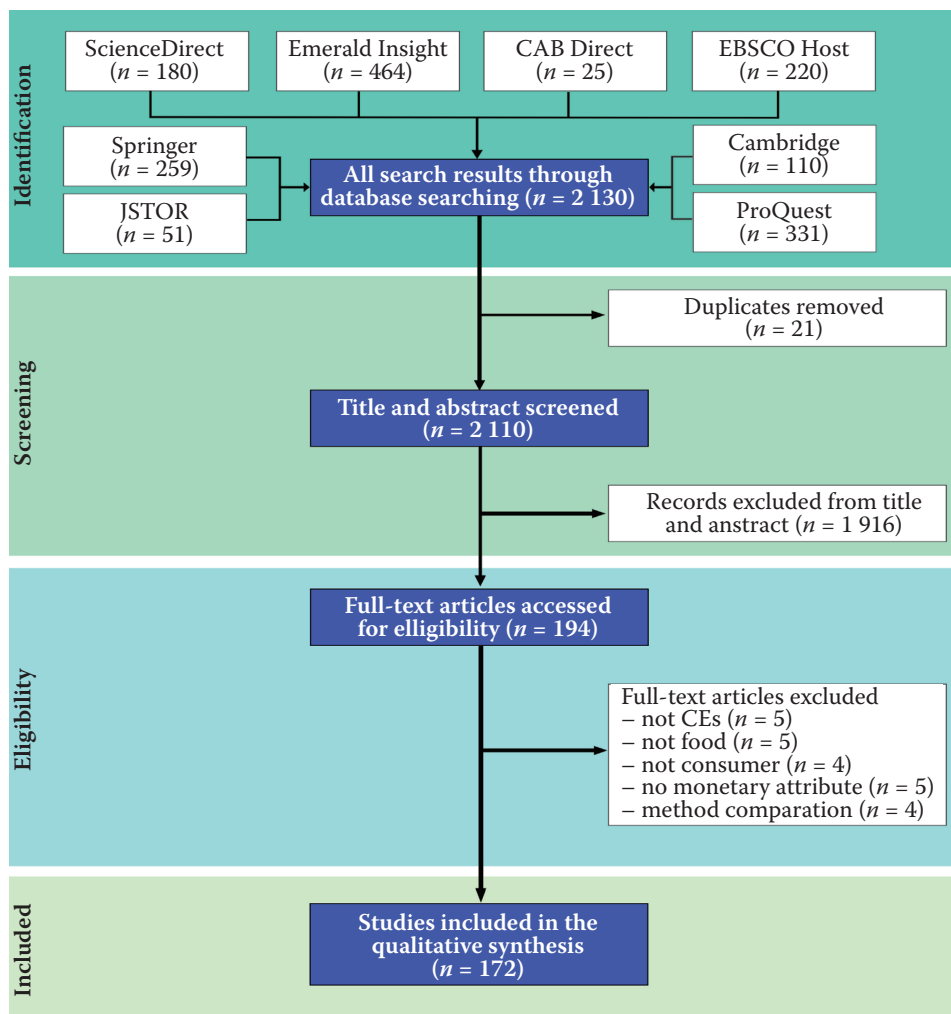
Figure 1. Data extraction diagram

CE – choice experiment
Source: Authors' own elaboration

cent studies have raised the theme of food technology, such as ribonucleic acid (RNA) interference, nutrition enrichment, and plant-based meat. The availability of protein sources and ethical considerations are the main points in the background of various studies. According to Pulina et al. (2021), future beef development
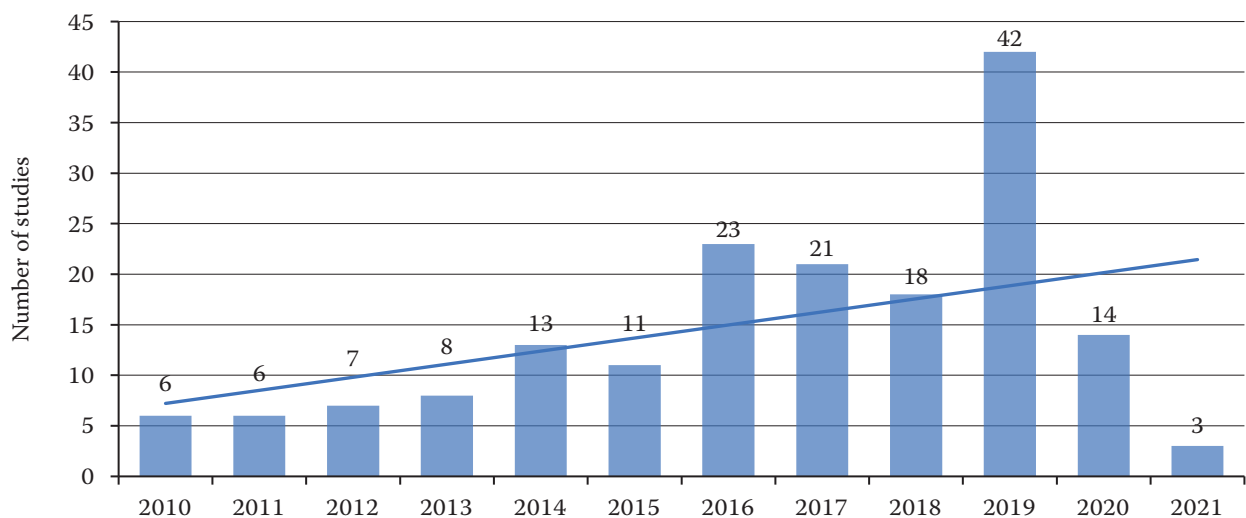

Figure 2. Distribution of choice experiment (CE) study on consumer food preference in 2010–2021

Source: Authors' own elaboration

Review

Table 1. Types of food products used in choice experiment (CE) studies on consumer preference

Category	Frequency	Term used in the studies
Cereals	8	wheat (1), cereal (1), porridge flour (1), rice (5)
Roots, tubers, and plantains	2	ginseng (1), red ginseng (1)
Pulses, seeds, and nuts	3	almond (2), soy-based food (1)
Milk and milk products (dairy)	25	cheddar cheese (1), cheese (2), cream cheese (2), infant milk formula (1), milk (10), milk powder (1), strawberry yoghurt (1), white cheese (1), yogurt (6)
Eggs	5	eggs (4), organic eggs (1)
Fish and shellfish	16	fish steak (1), arctic char fish (1), finfish (1), fish finger (1), fishmeal (1), oyster (1), salmon (2), sea bass (1), sea urchin (1), seafood (2), shellfish (1), shrimp (1), white shrimp (2)
Meat and meat products	39	beef (9), beefsteak (1), broiler meat (1), chicken (2), chicken breasts (1), chicken meat (1), chicken nuggets (1), fried chicken (1), ground beef (2), horsemeat (1), Hungarian mangalitza salami (1), lamb (3), meat (3), meatball (1), minced pork (1), mortadella (1), pork (3), pork meat (4), red deer meat (1), salami (1), skinless chicken breast (1)
Insects and grubs	–	–
Vegetables	16	carrot (1), Chinese cabbage (1), spinach (1), sweet corn (1), tomato (8), vegetable (3), mushroom (1)
Fruits	21	apple (7), banana (1), blueberry (1), cherry (1), fresh fruit (1), fruit (3), fuji apple (3), pomegranate (1), strawberry (3)
Fats and oils	4	olive oil (2), virgin oil (1), virgin olive oil (1)
Sweets and sugars	7	brown sugar (1), honey (2), ice cream (1), apple sauce (1), processed blackberry jam (1), sugar (1)
Spices and condiments	2	sweet peppers (1), yellow chilli pepper (1)
Beverages	31	artisan fruit juice (1), beer (3), chocolate (2), cocoa (1), coffee (1), Kona coffee (1), mock wines (1), orange juice (2), rosé wine (1), tea (1), tomato juice (1), wine (16)
Foods for particular nutritional uses	3	fortified food (1), fortified drink (1), supplement (1)
Food additives	–	–
Composite dishes	8	bread (1), breadsticks (1), burgers (1), pasta dish (1), nugget (1), rye bread (1), sandwich (1)
Savory snacks	2	snack (2)

Numbers in parentheses indicate the frequency of occurrence; food categorisation by FAO's food group and sub-group
Source: Authors' own processing based on FAO (2022)

is related to the adoption of agroecological practices, production performance, and quality improvement. In addition, Henchion et al. (2021) stated that several countries have facilitated the development of alternative protein sources from plants, insects, algae, and microbes. In this review, Slade (2018) found that consumers perceive no differences in the taste between plant-based beef and beef in hamburgers, implying that plant-based meat has a great deal of potential in the food industry. However, this review did not find any study exploring insect-based food, algae, or microorganisms as alternative protein sources. It means that

CE applications to studies of consumer preferences for alternative protein sources is still lacking and needs more exploration.

Food safety and health benefits are inextricably linked to food additives. However, CE research has yet to include an examination of food additive products. Though not all food additives are harmful, one example is *Moringa oleifera*. With its biochemical content, this plant has the potential to be a natural food additive, enhancing the physicochemical features of food, as well as its quality and shelf life (Hodas et al. 2021). Another case is a blue food colourant. Since blue is extremely

Table 2. Number of attributes and categories used in choice experiment (CE) studies on consumer preference

Variable	n	(%)
Number of attributes*		
1–2	40	23.3
3–4	101	58.7
5–6	21	12.2
7–8	6	3.5
9–10	3	1.7
11–12	1	0.6
Attribute categories		
Product origin	114	18.7
Product characteristic	112	18.3
Production, preparation and harvesting method	96	15.7
Eco-friendly, animal welfare and sustainability	76	12.4
Certification	39	6.4
Sensory	38	6.2
Food safety, health claim	25	4.1
Traceability	20	3.3
Brand/producer	19	3.1
Packaging, label design	19	3.1
Product quality	12	2.0
Expiration	11	1.8
Rating/review	11	1.8
Message/warning	9	1.5
Consumer convenience	6	1.0
Point of sale	4	0.6

*Non-price attribute

Source: Authors' own elaboration

rare in natural ingredients, consumers frequently assume that blue foods contain synthetic colouring. A specific example, the blue dye generated by the reaction of genipin (*Genipa americana* L.) and the primary amine in milk has the potential to be a stable, versatile, and cost-effective natural blue food colourant (Landim Neves et al. 2021). A study on consumer preferences for natural food additives can provide valuable information for the food industry.

Sample size, software, data analysis, and research implication. We use ranges to categorise the data on the number of samples (Table 3). Most of the studies employ 101–500 respondents. Several studies employ a small number of samples (30–100 respondents), and less than a quarter of the studies take a massive sample size (more than 1 000 participants). The sample size can offer valuable information on the number of respondents who need to provide the appropriate representation for certain consumer groups. Certain studies reported a technique for determining the sample size for CE research, such as the rule of thumb (Johnson and Orme 2003; Orme 2010) and the parametric method proposed by Louviere et al. (2000). However, Johnson and Orme's rule of thumb (Johnson and Orme 2003) is not intended for the accuracy and reliability of data, while the parametric technique of Louviere et al. (2010) only focuses on the probability of the choice. Therefore, de Bekker-Grob et al. (2015) suggested preparing some elements before determining the minimum sample size: significance level, statistical power level, data analysing model [multinomial logit (MNL), conditional logit (CLOGIT), generalised multinomial logit (GMNL), random parameter logit (RPL)], initial belief about the values of the parameters, and the experiment design.

A software program is an essential part of running CEs. This review found that Ngene was the most frequently used software, followed by SAS, NLOGIT, and Sawtooth Software, which are designed explicitly for CEs. However, other studies used multi-statistical software: STATA, SPSS, XLSTA, and MATLAB. Few studies used open-source software: R and BIOGEME, which are free to access. R software is growing in popularity among CE researchers (Yin et al. 2017; McPhedran and Toombs 2021). R software enables users to create and develop statistical features as a package. The most popular package for CE is 'support.CEs' proposed by Aizaki and Nishimura (2008), and the GMNL package by Sarrias and Daziano (2017) is popular for MNL analysis.

RPL is the most frequently used logistic model for data analysis, followed by MNL, mixed logit (MIXLOGIT), and CLOGIT. Utility coefficient data allow researchers to analyse consumer segments based on their preferences using a latent class analysis (LCA). Less than half of the studies performed a segmentation analysis using LCA. Moreover, most studies calculate the consumer's WTP. CEs can provide a price signal for some food products through the WTP estimation, although the WTP estimation results on CE are sometimes too high (Johnson and Orme 2003; Cantillo et al. 2020). The WTP estimation in CEs utilises marginal substitution between monetary and non-monetary attributes. Although this estimate aligns with neoclassical economic theory, its external validity is unclear. Johnson and Orme (2003) proposed a market simulator to obtain a more realistic estimate of the WTP, which simulates the WTP from the utility of the data but adds competing features.

Table 3. Sample size, software, data analysis, questionaire and research implication of choice experiment (CE)

Variable	Frequency	(%)
Sample size		
30–100	6	3.5
101–500	74	43.0
501–1 000	57	33.1
1 001–1 500	18	10.5
1 501–2 000	7	4.1
2 001–2 500	6	3.5
2 501–3 000	2	1.1
3 001–3 500	0	0.0
3 501–4 000	1	0.6
4 001–5 000	1	0.6
Software		
Ngene	47	27.0
SAS/JMP	31	17.8
Nlogit	28	16.1
Sawtooth Software	22	12.6
STATA	19	10.9
R	10	5.7
SPSS	10	5.7
XLSTAT	5	2.9
Matlab	1	0.6
Biogeme	1	0.6
Data analysis		
MNL*	52	15.4
CLOGIT*	24	7.1
MIXLOGIT*	40	11.9
RPL*	56	16.6
Latent class	51	15.1
WTP	114	33.8
Questionnaire		
Offline	91	53.0
Online	81	47.0
Implication		
Marketing strategy	126	62.7
New product development	17	8.5
Policy recommendation	58	28.9

*Main analysis for consumer preference; MNL – multinomial logit; CLOGIT – conditional logit; MIXLOGIT – mixed logit; RPL – random parameter logit; WTP – willingness to pay

Source: Authors' own elaboration

Only a few studies have been undertaken in evaluating new product development. However, the capability of CEs to create hypothetical food product attributes would benefit a new product's development. Additionally, the food industry faces a high risk in a new product launch due to the lack of information on consumer preferences (Kendall et al. 2019).

CONCLUSION

Along with the development of the agri-food industry around the world, knowledge of consumer preferences for food product attributes is becoming very important as an input in improving the performance of the agri-food value chain as a whole. The growing use of CEs shows an increasing need for information on how consumers perceive the attributes and characteristics attached to food products. Despite developed countries dominating the application of CEs, this method has promising advantages in developing countries; researchers need to deliver clear briefings to the respondents regarding the CE questionnaire to eliminate any bias.

Some of the potential topics for future CE studies are healthier wines with reduced alcohol content and specific food ingredients, such as alternative protein sources and natural food additives. Additionally, we recommend conducting studies on alternative food ingredients in undeveloped or emerging countries. By understanding community preferences, the local government can develop a participatory policy. More specifically in the marketing topics, analysis of consumer responses to new food products requires more attention due to the current lack of information on this subject. Given the low success rate of new product marketing in the food business, we encourage food companies to conduct CE studies to ascertain consumer preferences so that new product development can be directed to consumer demands.

Technically, the CE approach can be implemented using a variety of software platforms, including those specially built for CEs, multi-statistical packages, and open-source software. We highly encourage the use of open-source tools such as R and Biogeme because they are free, flexible, and well-known in the statistics world. Additionally, LCA and WTP analyses are subsets of advanced analysis techniques. Even though some scientists consider that the WTP in CEs cannot capture the real consumer valuation, researchers can take advantage of the data to make a pricing estimation.

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