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TOWARDS MORE SUSTAINABLE PRODUCT DESIGN THROUGH CONSUMER EXPERIENCE

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Abstract. It is known from various studies that the choice of the drinkware could deeply affect consumer perception during beverage consumption. In our previous study we have demonstrated that there are a lot of differences in the ratings of taste, palatability bitterness and saturation were noted depending on the type of vessel in which beer was served. This study continues our previous research and expands it even further. In this study we test four different types of beer – each one with a different essence content. This is to determine whether glassware type affects customer experience from drinking each type of beer. Four types of beer purchased from different producers were used for the research. Beer samples for evaluation were served in beer mugs with a classic design and solid construction, tall glasses (wheatbeerglasses) with a characteristic elongated shape, and beer goblets (also called tulip glass), distinguished by a short stem and a very large bowl that tapers towards the top. The experimental results showed how the characteristics of a glass could affect beverage bouquet and flavour, and suggest that their rational optimization, based on experimental data, could enhance the consumer enjoyment of it. Taking into account the above studies, certain conclusions can be drawn regarding the research we conducted. Light beer with an essence content 12% served in a tulip glass has been assessed worse in every single tested trait. Odour, taste, saturation, palatability, bitterness and general quality index (GQI) have been perceived worst when the beer was served in tulip glass. It seems that tulip glass is particularly unsuitable for this type of beer. Moreover, sustainability considerations are becoming increasingly relevant in this context. Understanding the interactions between the drink and its container may foster more deliberate and responsible purchasing behavior. The above-mentioned factors also affect the consumer experience that can be created by combining a drink with the right glass.

Keywords: beer quality, glass quality, sensory evaluation, sustainability, design, glass-beverage interactions, consumer experience

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JEL Classifications: L15, L61, L66

1. Introduction and review of literature

Drinking and eating is a multisensory experience, and the appearance of a beverage can shape our expectations (Van Doorn et al., 2019) Beer is one of the most consumed beverages, representing 78% of alcoholic beverages worldwide (Gonzalez Viejo et al., 2022) People generally associate beer with alcohol with positive emotions. (Sandilya et al., 2023)

Due to its popularity, growing demand and availability of new technologies and materials, the beer industry has become a highly competitive market where improvement and innovation have become necessary. Historically, vessels have been looked upon solely as a device to transfer beverage from container to mouth, and design has not focused upon scientific principles. (Manska, 2018) Today different ideas have been created in the beer industry to

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improve consumer's experience. Some of them include cross-industry strategies like serving beer in certain type of glassware. Packaging and the type of glass used for consumption can be a key factor influencing the customer experience (Hernández-Mora et al., 2022) (Gonzalez Viejo et al., 2022) Glass has been a preferred packaging material for decades, and its role in the brewing industry is crucial. It has a positive impact on the quality of beer and is also preferred for ecological reasons. (Nieto-Villegas et al., 2024) Glass vessels (like beer mugs, tulip glasses etc.) are also most popular when it comes to beer consumption. New drinking vessel concepts are initiated by glassware and beverage companies to increase sales or create a perceived style identity for a particular beverage. (Manska, 2018) Previous studies have shown that consumers maintain that beer in glass bottles has a better aroma and taste than beer in cans, confirming how packaging can have a psychological impact on consumer perceptions of product quality (Elzinga et al., 2015) (Maria Merlino et al., 2020)

Several studies have found that the magnitude of user satisfaction is associated with a user's amount of experience with the product or system under evaluation. (Borsci et al., 2015) (McLellan et al., 2012) (Lindgaard & Dudek, 2003) Numerous studies have been conducted on how consumers perceive the sensory characteristics of beer in various situations. (Blackmore et al., 2022) examined how sensory and hedonic expectations shape perceived properties of regular and non-alcoholic beer. They demonstrated that product-related cues can significantly influence consumer's perception of taste, flavour and mouthfeel and that these effects are mediated by expectations. (Nieto-Villegas et al., 2024) tested consumer expectations towards craft and industrial beers, and eco-friendliness of beer's packaging. They report that beer consumers have an unfavourable perception of aluminium cans and more favorable towards glass. (Yang & Raghubir, 2005) tested how consumer expectations influence perceived quality of beer packaging (glass bottles and metal cans). They suggest that the differential purchase quantities

for bottles and cans are contingent on the context for which beer is being purchased. The study conducted by (Sandilya et al., 2023) revealed that the texture of the glass affected liking in a non-alcoholic beer sample. They used four different containers with distinct textures, named Plain, Bubbly, Prickly, and Ceramic, to evaluate their impact on the sensory properties of two beer samples. They also found out, that using a ceramic vessel with a different visual appearance than the other three glasses did not significantly affect the perception of the sensory attributes of the samples. In the study conducted by (Ribeiro et al., 2021) respondents were asked about their impressions and expectations regarding five craft beers of different colors, served in seven beer glasses. They discovered that color of craft beers influenced the expectations of consumers and experts, so that craft beer with similar colors was associated with the same glass shape. It was concluded that the beer glass shape could directly influence the consumer expectancy on craft beers. Other researchers have found that the right glass can increase or decrease alcohol consumption, depending on its shape. (Troy et al., 2015)

The preceding literature review demonstrates that a wide range of factors can influence how sensory impressions are evaluated. Continuous innovation in glassware design has resulted in an expanding diversity of forms intended to complement traditional styles. However, this abundance of shapes and types of drinking vessels can also create uncertainty among consumers when selecting the most suitable option. Scholars further note that it remains unclear whether findings regarding the impact of glass shape on the perception of wine's organoleptic characteristics can be generalized to other, less complex beverages such as soft drinks, beer, or mixed drinks (Spence & Doorn, 2017) Given these uncertainties, further investigation into how the form of a glass vessel influences the sensory and psychological experiences associated with consuming different types of beverages appears well justified. The outcomes of such research could be beneficial not only for consumers, by guiding more informed purchasing decisions, but also for manufacturers, who may use this knowledge to refine product design and marketing strategies. The product has a combination of tangible and intangible attributes offered by firms for purchase. (Lin & Cheng, 2017) Shape, visual appearance and weight can be mentioned among many tangible attributes. (Chien et al., 2016) Subjective consumer experiences resulting from interactions with other products are intangible attributes. Results revealed five primary factors contributing to meaning-making and value creation – consumer requirements; simplicity; the context of user behavior, preferences, and experiences; elements determining the perceived product quality; and traditional culture. (Bin Ali et al., 2025) All of these factors can be applied to the design of glassware to achieve the best interactions between the product and the beverage.

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Moreover, sustainability considerations are becoming increasingly relevant in this context. Understanding the interactions between the drink and its container may foster more deliberate and responsible purchasing behavior. As previous studies have shown, consumers' perceptions of beverage quality significantly affect their product-related choices (Mehta et al., 2022). Consequently, when consumers select glassware that aligns more closely with their actual needs, they simultaneously contribute to a reduction in the consumption of natural resources and support more sustainable patterns of consumption.

It has long been known that our representations and beliefs influence our daily decisions, especially in consumption. Therefore, to better understand consumer behaviour towards a given product, it is crucial to know how it is represented (Sester et al., 2013) (Hernández-Mora et al., 2022)

Certain expectations may also result from the associations that users have with different types of glass. In our previous study we have demonstrated that there are a lot of differences in the ratings of taste, palatability bitterness and saturation were noted depending on the type of vessel in which beer was served. (Dubis & Baran, 2025) This study continues our previous research and expands it even further. In this study we test four different types of beer – each one with a different essence content. This is to determine whether glassware type affects customer experience from drinking each type of beer.

2. Materials and methods

Four types of beer purchased from different producers were used for the research:
- light beer with essence content 12%,
- light beer with essence content 14%,
- dark beer with essence content 11,9%
- porter beer with essence content 20%

Beer samples for evaluation were served in beer mugs with a classic design and solid construction, tall glasses (wheatbeerglasses) with a characteristic elongated shape, and beer goblets (also called tulip glass), distinguished by a short stem and a very large bowl that tapers towards the top. The mugs are used for beers such as lager. IPAs, for example, are served in mugs whose shape helps bring out the full flavor of the beer. Tall glasses were designed for wheat beers. The appearance of the glass used in the study is shown in **Błąd! Nie można odnaleźć źródła odwołania.**.

Photo 1. Glassware used in the study. Beer mug (left), tall glass (center), tulip glass (right)
Source: own photography

In this paper qualitative studies have been used. This type of studies collect information from various stories and experiences to understand the link between consumer and product. The study of how ideas, events or objects are represented in language and how they make sense to people, as well as the elements that influence thoughts, feelings and behaviour of people, have been investigated with qualitative approaches. (Hernández-Mora et al., 2022) There are a number of standards designed to ensure that a qualitative approach produces objective and high-

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quality results. In this study (*PN-ISO 6658:1998 Analiza sensoryczna. Metodologia. Wytyczne ogólne*), (*PN-ISO 4121:1998 Analiza sensoryczna. Metodologia. Ocena produktów żywnościowych przy użyciu metod skalowania*) and (*PN-A-79095 Piwo - Pobieranie i przygotowywanie próbek*) standards were used to ensure accuracy and repeatability of results. The sensory evaluation of the beer was performed by a trained 10-person team with appropriate, verified sensory sensitivity. The most important participant characteristic is that the participant is representative of the population of end users to whom the administrator wants to generalize the results of the test. (Lewis & Sauro, 2021) So all the evaluators declared, that they are beer consumers. The beer samples were assessed in three sessions. In each session beer were served in different type of the container. In the first session, beer samples were poured into mugs, in the second into tall glasses and in the third into tulip glass. In each session, each assessor assessed nine beer samples. The assessment was aimed at determining the level of organoleptic characteristics of beer (odour, taste, palatability, saturation and bitterness) using a 6-point scale according to PN-ISO 4121:1998 and determining on this basis the overall quality of the assessed beer types. Each point of the scale corresponded to a clear definition of quality. The scale included 6 quality levels of the assessed parameters:
High quality - very good - 6 points; good - 5 points.
Acceptable quality - average - 4 points; poor - 3 points.
Low quality - very poor - 2 points; bad - 1 point.

After each session, a General Quality Indicator was calculated for each type of beer using the following formula:
$GQI = \Sigma C_i * W_i$, in which:
GQI – General Quality Indicator
C_i – evaluation of the consecutive sensory features;
W_i – weighting coefficient of the consecutive sensory feature (smell – 4, taste – 8, palatability – 12, saturation – 2, bitterness – 4). The weighting coefficients were adopted according to Annex D of PN-A 79093-1-2000-P.

The results were statistically analyzed using Statistica 13.3 software. The following methods were used in the analysis:
- calculation of basic statistical measures – arithmetic mean (M) and standard deviation [Sd],
- one-way analysis of variance – Fisher-Snedecor parametric F test combined with post-hoc analysis, in which the least significant difference (NIR) test was used. These tests were used to examine the degree of differentiation of assessments between individual experts
- Kruskal-Wallis nonparametric test for a one-way system. This test was used to examine the differentiation of assessment results depending on the type of beer and the type of vessel. In the case of rejecting the null hypothesis, an additional post-hoc analysis was performed using Dunn's multiple comparisons test with Bonferroni correction.

Verification of all hypotheses was performed at the significance level of $\alpha = 0,05$ based on the test probability value "p". It was assumed that $p \leq 0,05$ It was assumed that $p \leq 0.05$ indicates significant differentiation of the dependent variable depending on the category of the qualitative factor. (Stanisz, 2006)

3. Results and discussion

The results of the organoleptic quality assessment (GQI; mean and standard deviation values) of the tested beers performed by individual experts are presented in Table 1.

Table 1. Results of organoleptic quality assessment (GQI) of the tested beers

Evaluator no.	Mean	Standard deviation
1	4,81	0,40
2	3,86	0,68

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3	4,86	0,69
4	5,18	0,82
5	4,68	0,74
6	4,32	0,67
7	4,31	0,68
8	4,77	0,63
9	4,83	0,79
10	4,50	0,88

Source: own study

Test F showed that the average GQI score scores of all beers combined vary depending on the person performing the assessment (Table 1). The NIR test showed that the No. 2 and No. 4 evaluators were particularly different from the team. Therefore, further analysis of the results was performed for a team of 8 people, omitting evaluators no. 2 and 4.

The results of the organoleptic quality assessment of all beer samples evaluated in different vessels are presented in Table (mean values for eight evaluators). The nonparametric Kruskal-Wallis test showed significant differences in organoleptic quality. The test probability value "p" is 0.047. A post-hoc analysis of Dunn's test showed that the highest quality level was assessed for light beer with an essence content 14%, and the lowest level was assessed for the organoleptic quality of light beer with 12% essence

Table 2. Results of organoleptic quality assessment (GQI) of various types of beer

Beer type	mean
light beer with an essence content 12 %	4,51
light beer with an essence content 14%	4,98
dark beer with an essence content 11,9%	4,69
porter beer with an essence content 20%	4,75

Source: own study

There are also significant differences between the quality of beer served in a different vesels. Post-hoc analysis using Dunn's test showed that beer served in a tulip glass was rated lower than beer served in a mug and a glass. (table 3)

Table 3. Results of the organoleptic quality assessment (WJC) of all types of beer evaluated in different vessels

Glass type	mean
beermug	4,90
tulip glass	4,45
glass	4,73

Source: own study

The results of the organoleptic quality of different beer types served in different vessels are presented in Table 4. The Kruskal-Wallis test demonstrated a significant effect of vessel type on the organoleptic quality of light beer with an essence content of less than 13% and dark beer ($p < 0.05$). Post-hoc analysis using Dunn's test revealed that:

- the average quality level of light beer up to 13% essence is lower when served in a glass than when served in a tulip glass or beermug.
- the average quality level of dark beer is lower when served in a glass than when served in a tulip glass or beermug.

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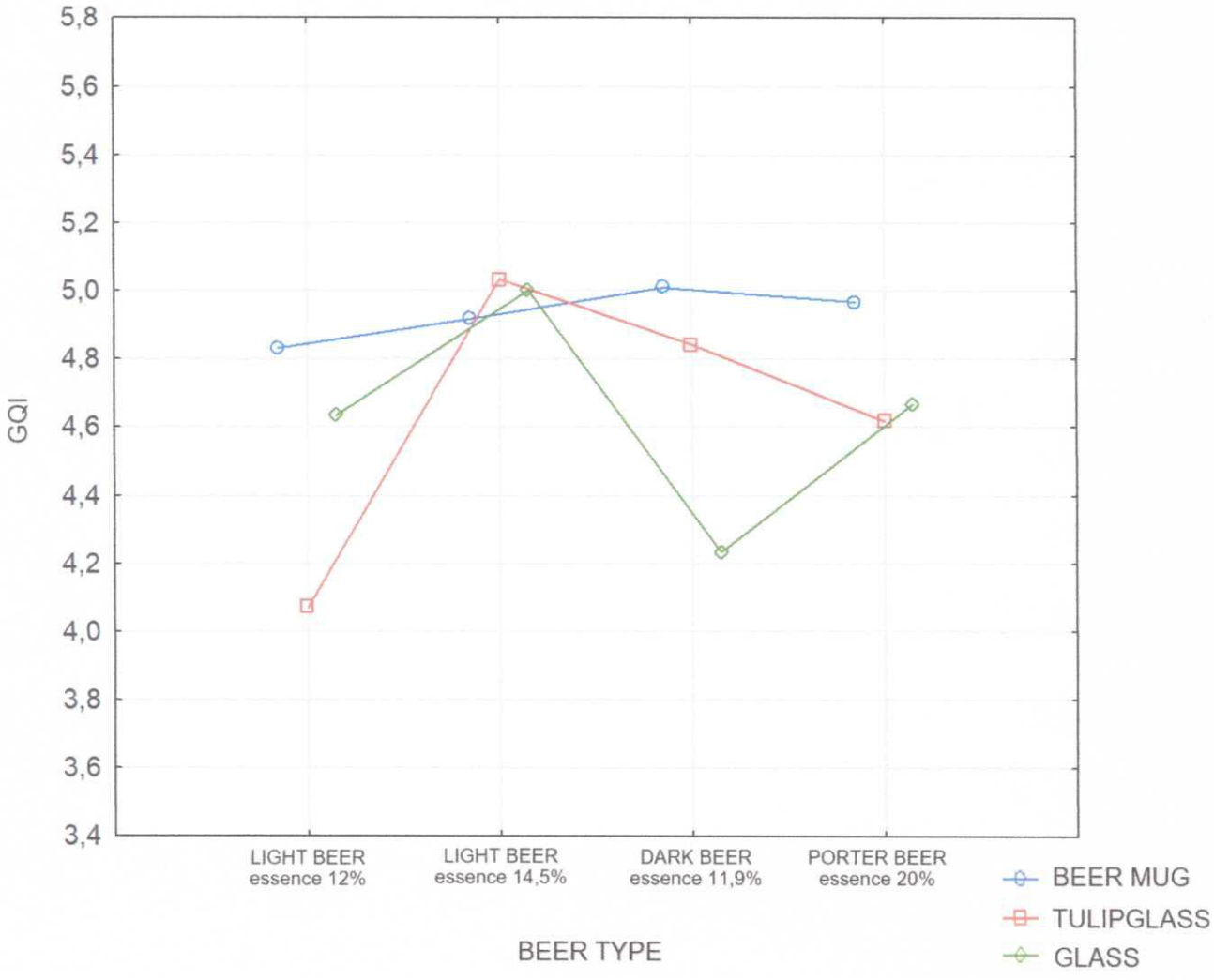
Table 4. Results of the organoleptic quality assessment of individual beer types served in different vessels[1]

	light beer with essence content 12%	light beer with essence content 14%	dark beer with essence content 11,9%	porter beer with essence content 20%
beermug	4,83b	4,92	5,01b	4,97
tulip glass	4,07a	5,03	4,84b	4,62
glass	4,63b	5,00	4,23a	4,67
	p value			
	0,001	0,907	0,029	0,556

Source: own study

The results summarized in Table 4 are also presented in Figure 1. At a significance level of 0.05, it can be concluded that the type of vessel affected the organoleptic quality assessment of light beer with an essence content below 13%. This quality was assessed at a significantly lower level when the beer was served in a tulipglass compared to the other two vessels.



[1] The same letter symbols next to the mean values indicate that there is no difference between them in Dunn's test.

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Figure 1. Organoleptic quality level of individual beer types assessed in different vessels

The research results indicate the existence of statistically significant differences in the assessment of the organoleptic characteristics of different beers served in different glasses.

Tabela 6. Poziom cech organoleptycznych różnych gatunków piwa w zależności od rodzaju naczynia[2]

	light beer with essence content 12%	light beer with essence content 14%	dark beer with essence content 11,9%	porter beer with essence content 20%
	p value			
Odour	0,379	0,511	0,333	0,804
Taste	0,015*	0,431	0,245	0,176
Palatability	0,014*	0,623	0,269	0,133
CO_2 saturation	0,042*	0,930	0,116	0,400
Bitterness	0,023*	0,556	0,174	0,499

Significant differences in taste, palatability, saturation and bitterness depending on the type of vessel were noted for light beer with an essence content 12%

[2] The symbol * indicates significant differences in the level of the feature depending on the type of vessel

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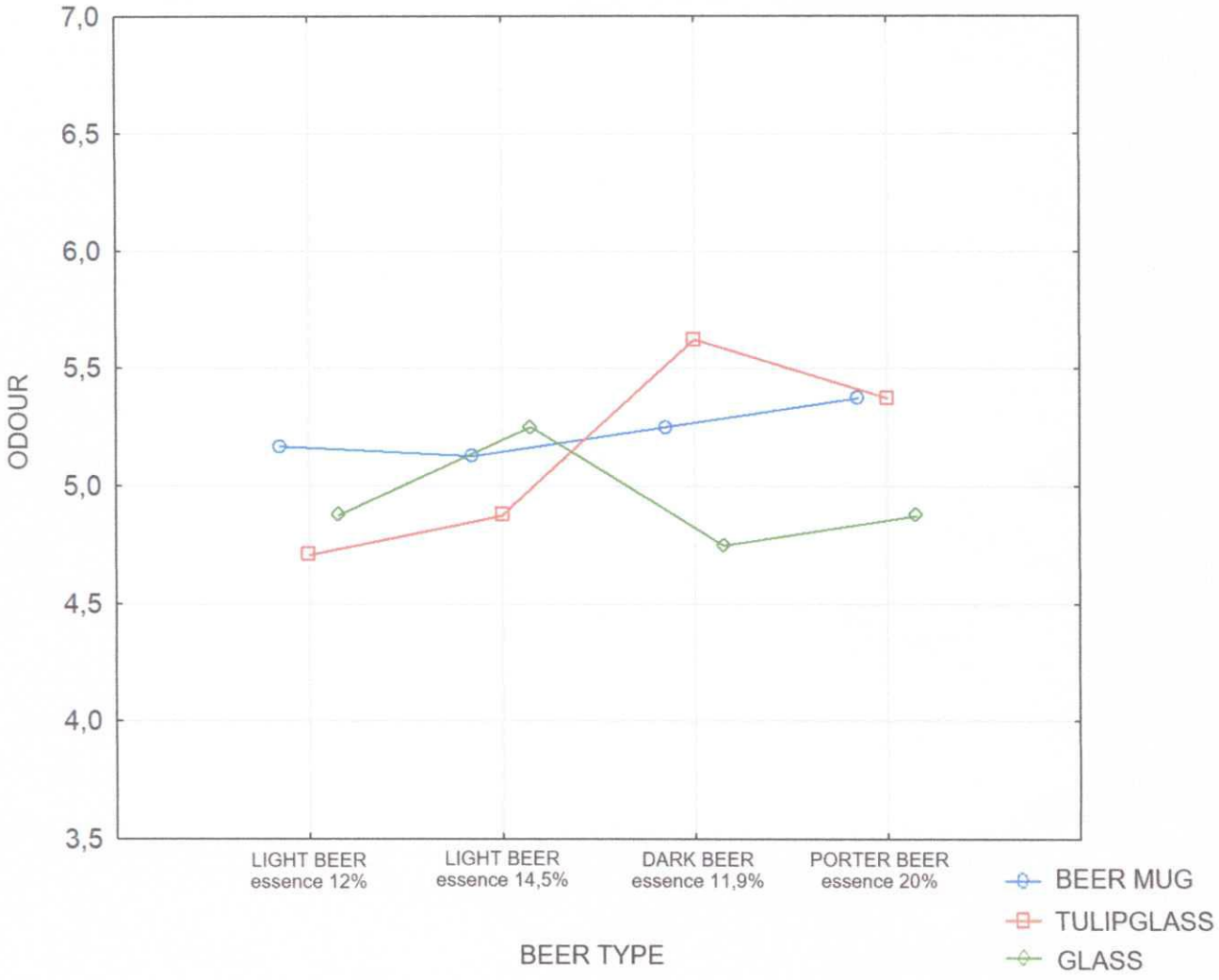

Figure 2. Odour of different types of beer evaluated in different vessels
Source: own study

At a significance level of 0.05, it can be concluded that the type of container had no effect on the aroma assessment results for all beer varieties.

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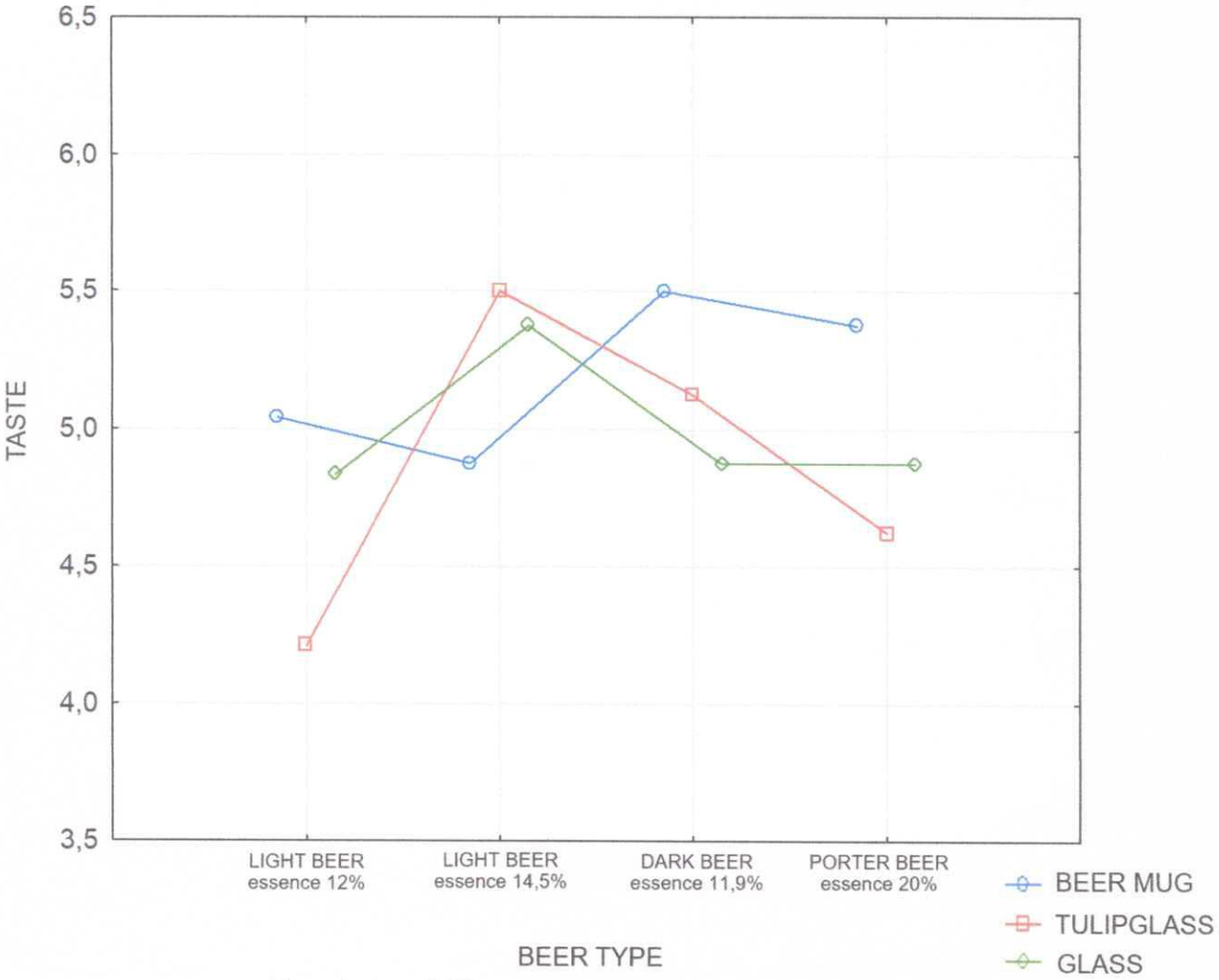

Figure 3. Taste of different types of beer evaluated in different vessels
Source: own study

The bitterness of a light beer with an essence content 12% served in a tulip glass was assessed at a lower level than beer served in the other two types of vessels.
Differences are noted in the case of porter beer (average scores for samples in a glass are higher by about 0.8 points than the average scores for samples in a tulipglass), but these differences are not statistically significant.

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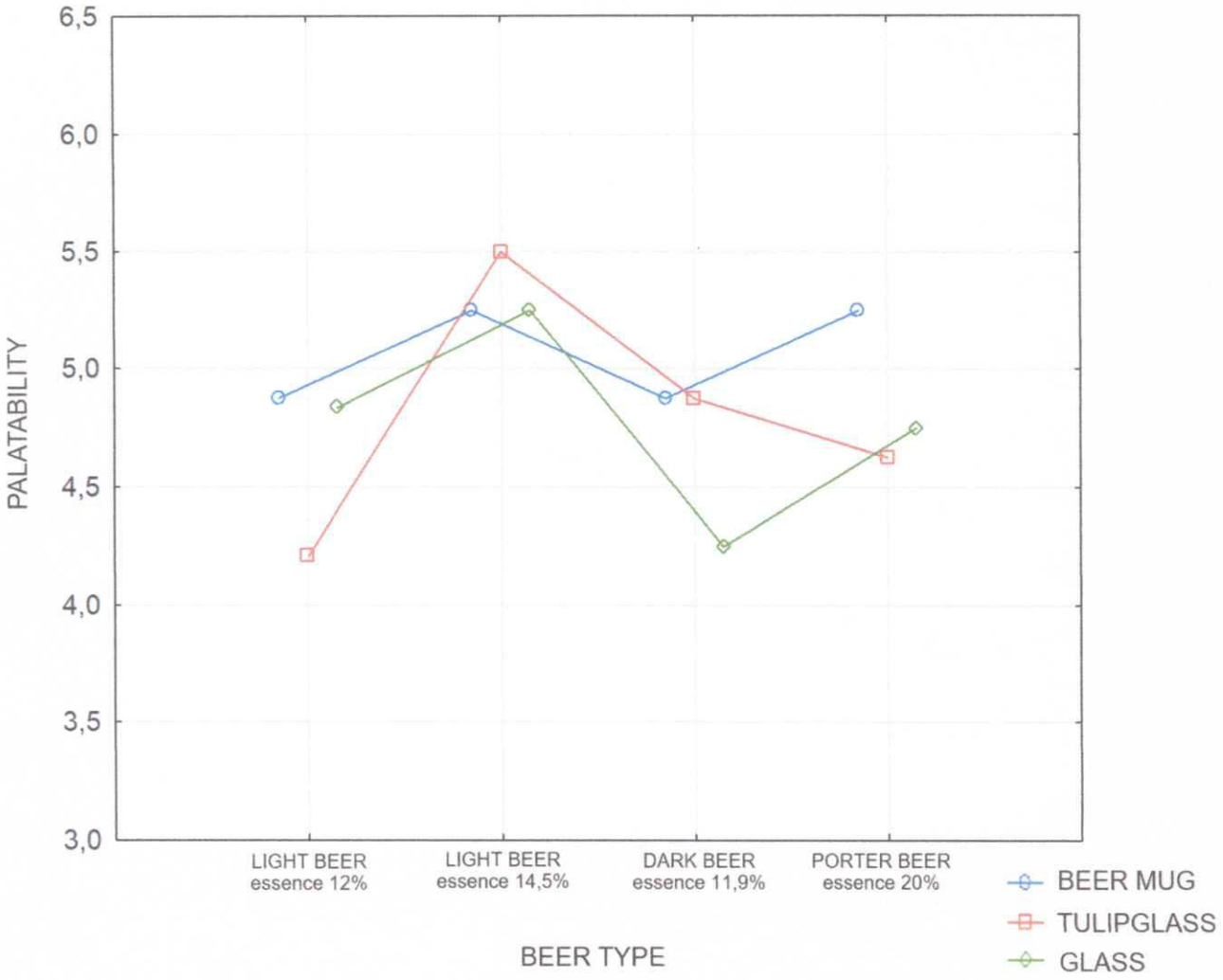

Figure 4. Palatability of different types of beer evaluated in different vessels
Source: own study

In the case of light beer with an essence content 12% the palatability of this beer served in a tulip glass was assessed at a lower level than the palatability of the same beer served in a glass or in a beer mug.
Differences are noted in the case of the palatability scores for the other beer varieties. There are some differences in the case of porter (the average scores for the samples in a mug are higher by approximately 0.7 points than the average scores for the other samples), but these differences are not statistically significant.

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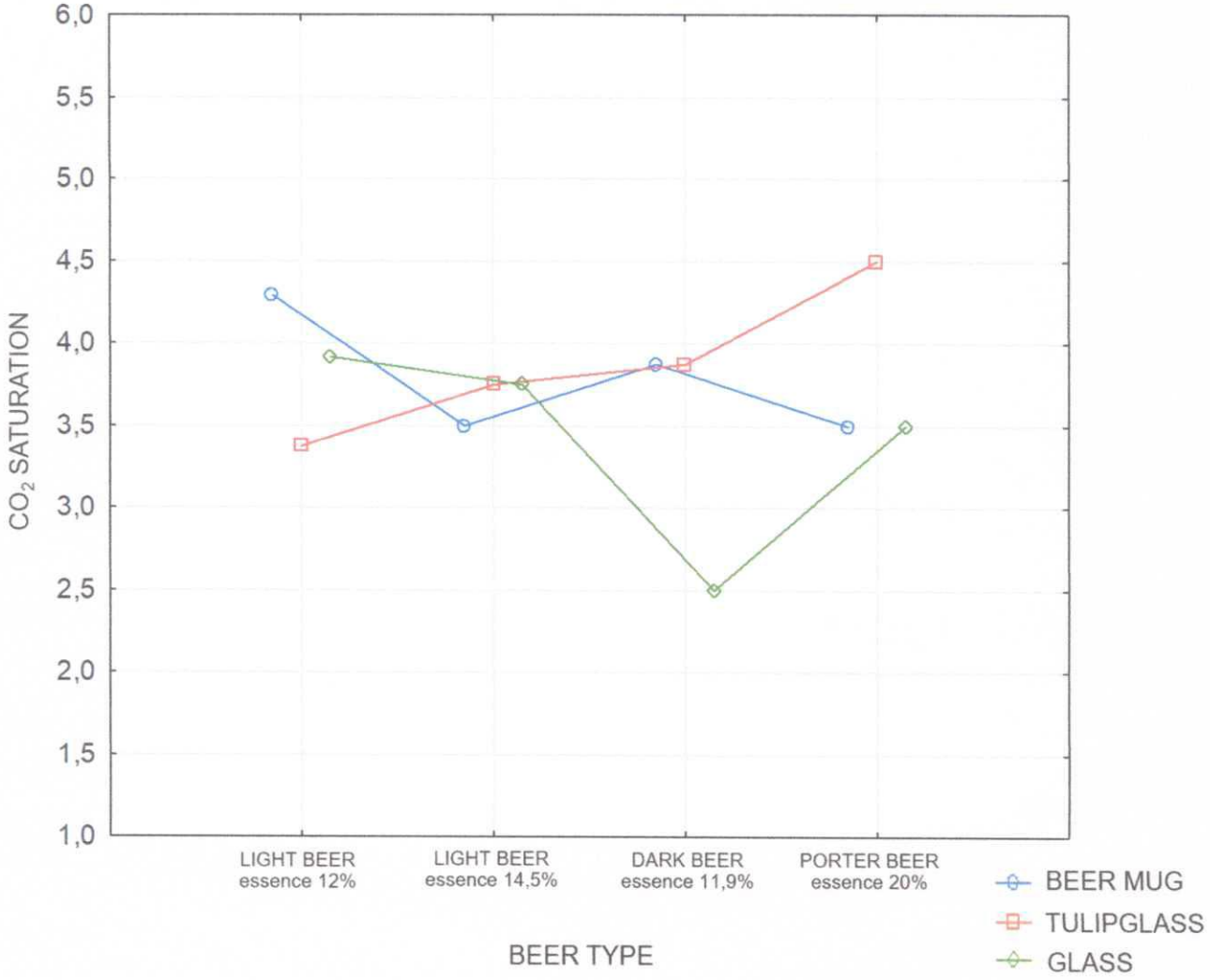

Figure 5. CO_2 saturation of different types of beer evaluated in different vessels
Source: own study

The saturation of a light beer with an essence content 12% served in a tulip glass was assessed at a lower level than beer served in a mug. The type of vessel did not affect the results of the assessment of the saturation of other types of beer.

Differences are noted in the case of dark beer (average scores for samples in a glass are lower by about 1.5 points than the average scores for samples in a mug and a tulipglass), but these differences are not statistically significant.

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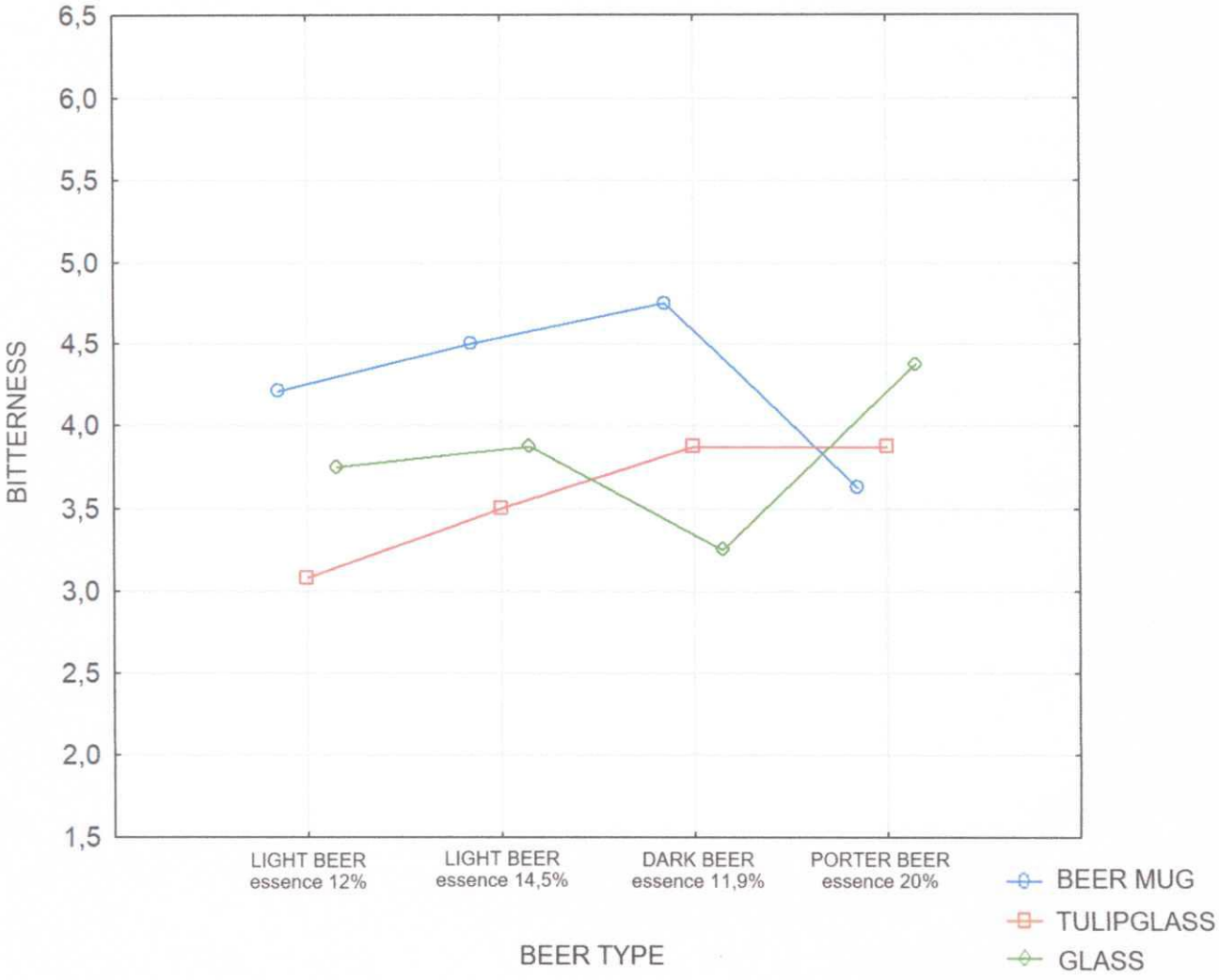

Figure 5. Bitterness of different types of beer evaluated in different vessels (mean values)
Source: own study

The bitterness of a light beer with an essence content 12% in a tulip glass was assessed at a lower level than beer served in a mug.
Differences are noted in the case of dark beer (average scores for samples in a glass are lower by about 1.5 points than the average scores for samples in a mug and a tulipglass), but these differences are not statistically significant.

Conclusions

The conducted research expands the current knowledge on the influence of the shape of the vessel on the experience of drinking beer. When people are aware of the shape properties of the glass that they are drinking from (which is normally the case), then serving beer and wine in curved glasses brings out the fruitiness in the drink. (Cliff, 2001) (Mirabito et al., 2017) (Ribeiro et al., 2021) In such cases, it is natural to consider the shape features of the glassware as affecting physicochemical properties of the volatiles in headspace over the glass. But it would seem more likely that it is the psychologically determined correspondence between taste and shape, especially

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given research showing that simply varying outer texture of drinking vessel can also bias taste ratings. (Spence, 2023)

The choice of the drinkware could deeply affect consumer perception during beverage consumption. Several studies investigating drinking experiences have focused on how the presentation of a beverage in a particular type of container influences its perceived quality and appropriateness. Research in this area has consistently demonstrated that participants tend to evaluate beverages more positively when they are served in vessels that are regarded as suitable or "appropriate" for that specific drink. (Spence & Doorn, 2017) This suggests that the physical context of consumption — particularly the choice of glassware — can significantly shape sensory expectations and subjective experience.

The idea of what constitutes an appropriate container, however, is not universal. It is often derived from previous personal experiences, social norms, and cultural conventions that associate certain beverages with specific forms of glassware. Over time, these learned associations establish a kind of perceptual template that informs consumers' expectations about how particular drinks should be served. For instance, the shape and style of a wine glass, beer mug, or cocktail glass carry symbolic meanings that guide perceptions of quality, taste, and even authenticity. Consequently, some glass types have come to be perceived as inherently better suited for certain beverages than others. (Casales-Garcia et al., 2023)

Taking into account the above studies, certain conclusions can be drawn regarding the research we conducted. Light beer with an essence content of less than 12% served in a tulip glass has been assessed worse in every single tested trait. Odour, taste, saturation, palatability, bitterness and general quality index (GQI) have been perceived worst when the beer was served in tulip glass. It seems that tulip glass is particularly unsuitable for this type of beer.

The experimental results showed how the characteristics of a glass could affect beverage bouquet and flavour, and suggest that their rational optimization, based on experimental data, could enhance the consumer enjoyment of it.

This study leads to similar conclusions to those drawn by (Ribeiro et al., 2021) that the shape of the glass can influence consumer expectations regarding different beers. This conclusion leads to some practical applications namely that most expected combination of beer and glasses could be used by bar or pub owners to deliver a better experience to their consumers. Additionally, this findings can also lead to new market strategies by defining a specific combination of beverage and glass shape that the consumers expect to see. Designersneed to manage to comprehend and translate users' requirements into corresponding functionality and pleasing aesthetics. (Li et al., 2024)

Another practical application of this study emerges. It has been suggested that effective interventions for changing routine or habitual behaviours should acknowledge the important role of automatic, non-conscious processes in shaping these behaviours. (Langfield et al., 2022) These two practical applications can be contradictory. The brewing industry, retailers, and restaurant owners are more interested in increasing alcohol consumption. Institutions such as the National Center for Addiction Prevention are working to reduce alcohol consumption. Knowledge about drinking behaviour would help to form any regulation-based policies, especially given that these policies are likely to be resisted by producers and retailers of the drinks targeted by the policy (Pomeranz & Brownell, 2014).

Last but not least practical application emerges from this study. In the contemporary context of sustainability, it is imperative to refrain from purchasing goods that do not fulfill an essential purpose. Consumers who possess an understanding of the relationship between the material properties of glass and the characteristics of beverages are better positioned to make deliberate and informed purchasing decisions. Accordingly, they should select glassware that optimally corresponds to the types of drinks they consume. From the producers' perspective, this awareness creates enhanced opportunities to design and supply products that align more precisely with consumer preferences and sustainability objectives. Nevertheless, this study has several limitations. The research focused primarily on how the shape of the glass influences the drinker's perception of beer with various essence content. However, only undecorated glassware was examined in this study. It would be worthwhile to assess how visual elements, such as decorative patterns or brand logos, might alter the drinker's perception. With the help of the insights gained, products can be better matched to customers' preferences. As a result, customers' needs are addressed early in the

product design process, the likelihood of complaints is reduced. These observations highlight the potential for further research on the interaction between various beer types and glass designs, opening new avenues for understanding user experience.

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