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Wine consumers' subjective responses to wine mouthfeel and understanding of wine body.

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Abstract :

Wine mouthfeel is considered important for wine quality by experts, while consumers understanding of mouthfeel and how they place importance of wine body is unknown. One experiment determined the influence of intrinsic wine mouthfeel on consumers' wine liking and emotions, and the other, how consumers understand the term wine body. The first experiment used a 2 astringency level × 2 body level experimental design. The samples were base wine with; nothing added (control), added xanthan gum (for increased body), added grape seed extract (GSE, for increased astringency), and with both added xanthan gum and GSE. The consumer taste trial (n=112) indicated that wine with increased body did not influence wine liking and emotions; while increased astringency decreased liking and elicited more intense negative emotions. The second experiment examined consumers' knowledge of wine body through an online survey (n=136). Consumers described wine body most frequently using words such as flavour, fullness, and strength. Wine body was therefore understood by consumers predominantly as a holistic multi-sensory perception of flavour. Wine flavour was indicated by consumers to be the most important factor driving purchase decisions followed by balance of flavours and wine body. It is crucial that wine professionals carefully communicate wine characteristics to consumers to prevent possible misunderstandings such as the meaning of wine body and as a result better meet consumer expectations. In future, the term body may benefit from a clearer definition for academic research as well as industry.

Keywords: Wine mouthfeel, Wine Body, Emotion, Liking, Content analysis, Consumer language.

1. Introduction

Mouthfeel is a major contributor to the sensory perception of wine (Gawel, Oberholster, & Francis, 2000; Pickering & DeMiglio, 2008) and is a tactile sensation in the oral cavity during consumption (DeMiglio, Pickering, & Reynolds, 2002). In wine, mouthfeel sensations include "*perceptions such as astringency, burning, prickling, viscosity, body, and temperature*" (Jackson, 2009). The chemical constituents that elicit these perceptions have been extensively studied; astringency, the puckering and drying sensation, is caused by polyphenolic compounds that are predominantly extracted from the skins and seeds as well as acids (Payne, Bowyer, Herderich, & Bastian, 2009; Pickering & DeMiglio, 2008; Vidal et al., 2004), and viscosity from either sugar, polysaccharides, and to some extent ethanol (DeMiglio et al., 2002; Gawel et al., 2014; Runnebaum, Boulton, Powell, & Heymann, 2011). Control of wine mouthfeel during production has important consequences to consumer's acceptance and preferences of wine (Bastian, Collins, & Johnson, 2010; Lattey, Bramley, & Francis, 2010; Stokes, Boehm, & Baier, 2013). The challenge for winemakers is to produce wine with appropriately balanced mouthfeel characteristics tailored to specific market segments, as liking of wine by mouthfeel is not homogeneous within a population (Biasoto, Netto, Marques, & Da Silva, 2014).

Wine body is another important sensory characteristic that is often used to describe wines in the wine industry as well as in the scientific community. Most frequently, wine body is mentioned on labels for consumer appeal, so as to broadly categorise wines into light, medium, and full bodied. This particular character however

has been challenging to study and little has been reported on its influence on consumers' hedonic evaluation of wines. Wine body is commonly used to describe mouthfeel in literature, suggesting that the sensation is of no exception to other mouthfeel characters; tactile characteristics in the oral cavity not including sapid characters (Guinard & Mazzucchelli, 1996; Laguna, Bartolomé, & Moreno-Arribas, 2017). As wines are reported to elicit complex mouthfeel sensations, a mouthfeel wheel was developed specifically for red wine (Gawel et al., 2000) and later white wine (Pickering & DeMiglio, 2008). The number of descriptions that relate to the category of wine body within the mouthfeel wheels in contrast to astringency is comparatively meagre, as well as being less specific. Clear definitions of wine body do not exist in literature despite being regularly used in definitions for other mouthfeel attributes. Wine body has been holistically described as the weight of wine resulting from the combined perception of alcohol, sugar, tannins, acid, flavour, and glycerol (Iland, Gago, Caillard, & Dry, 2009), though the role of glycerol in wine has been reported as a minimal contributor at levels found in wine (Noble & Bursick, 1984). The word body was ambiguously used together with flavour to define "watery" and "thin" under the category of "weight" in the red wine mouthfeel wheel (Gawel, et al. 2000). It was again used in the white wine mouthfeel wheel to define "weight", distinct from "viscosity", yet the reference standard for both these attributes was carboxymethyl cellulose (Pickering & DeMiglio, 2008). Thus, confusion remains around the precise meaning of wine body as researchers still lack the understanding of what it constitutes and whether it is the same as viscosity/thickness (Laguna et al., 2017). To add to this, such terms are specifically used by experts and are not necessarily appropriate for communication with regular wine consumers. Consumers are often unfamiliar with technical terms used by experts to

describe wine, a finding that was reported between two French cohorts (experts vs. consumers) (Le Fur et al., 2011). Regular wine consumers generally tend to use more holistic, abstract, allusive and hedonic terms than experts, who are more attuned to using technical, concrete and precise terms (Chollet & Valentin, 2001; Eric & Solomon, 1990; Gawel, 1997; Lawless, 1984; Valentin, Chollet, & Abdi, 2003). Further, consumers do not always understand jargon and may not find them useful to describe wine (Clapperton & Piggot, 1979). Attribute descriptions within the mouthfeel wheels have been pronounced as perhaps too technical for consumers (Vidal, Giménez, Medina, Boido, & Ares, 2015). Therefore, the question arises; how do consumers describe wine body if jargon does not apply?

Affective measures from consumers give an important indication of the potential performance of wine products and typically liking is measured. An additional measure to hedonics is consumer emotions. The study of emotions that are experienced throughout food and beverage consumption is considered a relatively new area of research. These measures become an important point of difference between similarly liked products (Jiang, Niimi, Ristic, & Bastian, 2016; Porcherot et al., 2012). A range of consumer emotions can be elicited by wines and emotions (either positive or negative) can change upon the consumption of wines as well as by the consumption context (Danner et al., 2016; Ferrarini et al., 2010; Jiang et al., 2016). Recently, it has been shown that consumer emotions can change depending on the flavours added to red wine, where positive emotions were elicited by a floral flavour whilst negative emotions were elicited by green flavour (Jiang et al., 2016). However, the effects of wine mouthfeel on wine consumers' emotions are poorly understood and little researched. This lack of understanding stems out to other food products also.

The work presented here had two main objectives: 1) to determine the effects of the intrinsic wine mouthfeel sensations of astringency and wine body on consumers' wine liking and wine-evoked emotions, and 2) examine consumers understanding of the term wine body. The first and second objectives were achieved by means of consumer wine tastings and an online consumer survey, respectively.

2. Materials and Methods

2.1. Study 1 – Consumer tasting of wines varying in body and astringency

2.1.1. Experimental design

To determine the effect of mouthfeel on consumers' wine liking and elicited emotions, a factorial design with two grape seed extract levels (GSE) × two gum levels was used. This gave four different types of wines; the control (no added GSE or gum), a wine with added xanthan gum (0.5 g/L) (The Melbourne Food Ingredient Depot, East Brunswick, VIC, Australia), a wine with added GSE (2 g/L) (Tarac Technologies, Nuriootpa, SA, Australia), and a wine with both added gum (0.5 g/L) and GSE (2 g/L).

2.1.2. Sample preparation

A range of base wines were considered for the consumer trial, as model wines are often disliked by consumers and thus inappropriate for consumer studies. Ultimately a commercial bottled of unoaked Semillon wine was used for its neutral flavour characters, as determined through bench top tasting of a series of wines with oenology staff members. To minimise the influence of olfaction on wine mouthfeel during tasting, the volatile aroma of the wine was reduced as much as possible by the addition of activated carbon (2 g/L) followed by filtration with a 0.45 uM polycarbonate membrane.

As bench top tests determined the wine to have a slight bitterness; sucrose (1.5 g/L) was added to mask the bitter taste. The commercial Semillon wine after carbon treatment and sucrose addition acted as the control, as well as the base wine to which mouthfeel agents were later added. Semillon with minimal mouthfeel was used as a "model" wine instead of red wine to allow for subsequent manipulation of mouthfeel character and thus to better understand the influence of changes in mouthfeel to consumers' subjective responses.

Although there is no general acceptance of the term wine body in the academic literature, an assumption was made for this study that wine body was related to viscosity, as the wine industry use the word frequently and consistently in such a way. To achieve a fuller bodied wine, six gums were initially compared in base wine by oenology staff in informal bench top tastings, however xanthan gum was selected for its solubility and low astringent character, the latter of which some of the other gums possessed. To determine and confirm the levels of xanthan gum and GSE for addition, a directional paired-comparison test was performed using experienced volunteers (n = 30) recruited from oenology staff and students at the University of Adelaide Waite Campus. These volunteers were educated in oenology and/or have worked in the wine industry, were all trained wine tasters and also had previous experience with descriptive analysis of wines. Accordingly, the volunteers were well aware of the meaning of body and astringency mouthfeel characters. The wines with additions of gum only (0.35 g/L) and GSE only (1.5 g/L) were compared against the control. Samples were served in black glasses in individual sensory booths under orange sodium light and pairs of samples were presented in a balanced order. Each volunteer was asked "*Which of the two wines has more body?*" and "*Which of the two wines has more astringency?* Correct responses for

wine with increased body and astringency tests were 21 and 27 out of 30, respectively. Data analysis by Chi-square test showed that addition of gum and GSE had significantly more body ($p<0.05$) and more astringency ($p<0.01$), respectively, than the control. To ensure a better discrimination of body and astringency by consumers, the final concentrations of xanthan gum and GSE for the consumer evaluation was increased to 0.5 g/L and 2 g/L, respectively.

Each wine sample was chemically analysed in triplicate for pH, titratable acidity (TA, g/L), sugar (g/L) by the Rebelein method, volatile acidity (VA, g/L), free and total SO_2 (mg/L) using the Markham still (Iland, Bruner, Edwards, Caloghiris, & Willkes, 2013), and alcohol level (% v/v) with the Alcolyzer (Anton Parr, Graz, Austria) (Supplementary Table 1). The pH, free SO_2, sugar and alcohol contents significantly differed ($p<0.05$, using general linear model analysis of variance (GLM-ANOVA)) across samples however these differences were thought negligible and were most likely too small to be detected by the consumers (Supplementary Table 1).

Prior to consumer testing, the base Semillon wine was carbon filtered a day before each trial and stored in 2 L Schott bottles under nitrogen gas coverage at 4 °C. Wines were equilibrated to room temperature (20 °C) for 3 hours before each session. At this point, gum and/or GSE were added according to the experimental design and solubilised with a stick blender.

2.1.3. Consumer recruitment and testing procedure

Consumers (n=112) were recruited via email, phone call, social media and fliers. The inclusion criteria for consumers were 18 years of age or older and regular consumers of wine i.e. at least once per month. All consumers were required to read the

information sheet, complaints form, and sign the consent form before participation. Prior to tasting, consumers completed an online questionnaire that covered their demographic details, including their gender, age, education, household income, wine consumption frequency, and wine style consumption in the past 12 months. Demographic information and wine consumption behaviour were determined from consumers (Supplementary Table 2). In brief, the consumers recruited were; of similar proportion for gender and regular wine consumers where 88% consumed wine at least once a week. The consumers' age ranged from 18 to above 60, in particular ages 18-29 and above 60 were the highest proportion of consumers tested with 32.1 % and 29.5 %, respectively. The majority of the wine consumers were well educated, with over 70 % having a Bachelor degree or higher, consistent with previous studies on Australian wine consumers (Cox, 2009; Jiang et al., 2016; Johnson & Bastian, 2007).

Tasting procedure information provided was:

"Place a small volume of wine into your mouth and roll the wine around in your mouth. Pay attention to the texture and mouthfeel of the wines."

The consumers evaluated all four samples, which were presented monadically in a randomised order for each consumer. All wines (30ml) were served in black INAO glasses (to mask potential biases due to changes in appearance caused by the addition of GSE and xanthan gum), coded with three digit codes, and covered with petri dishes. The blinding codes and randomisations were generated using Design Express (Product Perception, Berkshire, UK). Wines were evaluated in individual booths at 20 °C under orange sodium light.

For each wine, consumers were instructed to first taste and rate their liking of the wines on a 9-point hedonic scale (anchored with; 1=dislike extremely, 3=dislike moderately, 5=neither like nor dislike, 7=like moderately, 9=like extremely) "Please indicate how much you like or dislike this wine", followed by tasting and rating the intensity of 19 emotions on a 9-point scale (1=not at all, 3=slightly, 5=moderately, 7=very, 9=extremely) using the Australian Wine Evoked Emotions Lexicon (AWEEL) (Danner et al., 2016). This lexicon included 19 emotions terms, 11 of which were of positive valence (adventurous, calm, contented, enthusiastic, happy, nostalgic, optimistic, passionate, relaxed, surprised, and warm hearted) and the remaining eight of negative valence (embarrassed, envious, irritated, lonely, panicky, sad, tense, and unfulfilled). Lastly, "other" was included to give consumers an option to indicate an emotion that was not on the list. The assessors were instructed to provide their responses to the following:

"How strongly does wine No __ make you feel each of the following emotions."

The list of emotions was randomised for each consumer in every sample to reduce bias from the emotion judgement order. A minute break was provided in between each sample and during the break, consumers were instructed to cleanse their palate with filtered water and crackers. Testing was held at the University of Adelaide, Waite campus. The questionnaire data (demographic details), plus wine liking and evoked emotions were recorded using the sensory analysis and consumer tests management software Fizz acquisition Ver. 2.47b (Biosystèms, Courternon, France).

2.2. Study 2 – Consumer wine body survey

To determine the current understanding of term wine body and the types of sensory intrinsic characteristics associated with it from a consumers' perspective, an online survey was conducted.

2.2.1. Consumer recruitment

The survey was conducted in order to elucidate how consumers comprehend wine body as a sensory sensation and reveal the language they use to describe this attribute. Consumers for this survey were recruited from the consumer database of the University of Adelaide as well as social network sites. Consumers were initially screened for eligibility including residency status, age, and wine consumption (Australian citizen or resident, over 18 years old, had no formal wine education, not working in the wine industry, and had consumed wine at least once during the last month prior to the questionnaire) (initially n=286). A total of 195 responded to the survey. Some consumers held certifications related to wine education and/or currently worked in the wine industry (n=14), whilst others did not complete the entire survey and so their data was removed in order to focus on general and naïve wine consumers. The resulting sample size was 136 respondents. In brief, genders were in equal proportion, a wide range of age groups were captured between 18 and 60 +, and a high proportion of consumers were educated (Supplementary Table 3).

2.2.2. Survey

The online questionnaire presented with SurveyMonkey® consisted of five sections.

Section one: Consumers stated their demographic details including their age group, gender, highest level of education, household income, postcode and their usual budget

for a bottle of wine for home consumption.

Two questions were included to determine the consumer's level of wine expertise, which was used as a screening step. Consumers who gave any indication of experience in wine from education or work resulted in their removal from the data set as described above. The first question determined if consumers held any certifications related to wine education such as the Wine & Spirit Education Trust, Sommelier, or tertiary education such as oenology, and the second question as to whether they worked in the wine industry.

Section two: Consumers ranked in order of importance the intrinsic sensory characteristics of wine that they believe indicate quality. Broad descriptions were included in the ranking task, such as "*balance of flavours*", "*how wine feels in mouth*", "*wines ability to match food*", amongst others, including "*wine body*". This question was asked at the beginning of the survey to gain insight into the important wine characteristics for consumers, namely "*wine body*" and to prevent any bias from questions specifically on wine body later in the survey.

Section three: Consumers were asked about their understanding of the word "body" in wine. First, they were asked whether they use the word "body" to describe wines, followed by an open-ended question "*How would you describe wine body?"*. It was explained to consumers that there are no incorrect answers and an option was given to write "*I don't know*" when unsure.

Section four: Consumers were instructed to assign the level of wine body for a range of wines. Four categories were provided; *light-bodied, medium-bodied, full-bodied* and *unsure*. The wines listed were: *Riesling, Chardonnay, Gewürztraminer,*

Sauvignon Blanc, Semillon, Shiraz/Syrah, Cabernet Sauvignon, Grenache, Pinot Noir, Merlot, Rosé, Sparkling wine/Champagne and *Tawny/Port*. These options were selected for the survey on the basis that they were clearly identified to cover a wide range of wine body and relevant to the Australian market (Puckette & Hammack, 2015).

*2.3.*Section five: Consumers' subjective wine knowledge was assessed using the Goldsmith scale with five items rated on a nine point scale ranging from "totally disagree" to "totally agree" (Flynn & Goldsmith, 1999). This scale was added to confirm consumers' knowledge of wine and later the data used to segment consumers based on their subjective wine knowledge. The questionnaire consists of three positively and two negatively framed questions and as such, it also serves to reaffirm that the questions have been read and understood correctly by the consumers. *Data analysis*

To determine the influence of mouthfeel agents on liking and emotions elicited from the wines, data was analysed with univariate GLM ANOVA using SPSS statistics ver. 24 (IBM Corporation, Chicago, IL, USA). The liking and emotion scores were taken as the dependent variables; the samples were taken as a fixed factor; and consumers as random factor. Each of the fixed and random factors were analysed as main effects. The significantly different consumer responses ($\alpha = 5$ %) were subjected to post-hoc testing using Bonferroni correction.

The data analysis for the consumer survey is as follows. The ranking data of section two was analysed using Friedman's test with XLSTAT ver. 2015 1.03 (Addinsoft SARI, Paris, France). The open-ended question in section three was analysed with content analysis using a text mining software, Wordstat® (Version 7.1 Provalis Research, Montreal, Quebec). The pre-processing of the open-ended question data were treated using a method proposed previously (Le Fur, Teyssot, Foz, & Fours,

2013; Vidal et al., 2015). Stop words such as "the" and "a" were removed and spelling mistakes were corrected. Synonymous words were grouped together for ease of data analysis, e.g. "acidic", "acidity" and "acid" (grouped as "Acidity") (Table 1.), as well as a string of words that were similar in meaning such as "easy to drink" and "it goes down easy" (grouped as "Easy to drink"). Other groups made were more generic such as "Wine style" to denote wine variety ("Semillon", "Shiraz", "Cabernet Sauvignon" etc), colour ("red" or "white"), and food (salad, red meat, risotto etc). The final categories were analysed with frequency analysis to determine the percentage of consumers who used the different terms to qualify wine body. Categories mentioned by a minimum of 5% of the consumers have been included for analysis (Vidal et al., 2015).

Data obtained from the Goldsmith scale were calculated for their descriptive statistics and determined three groups of segments using interquartile differences. Three groups, lower 25 %, middle 50 %, and the upper 25 % percentile were extracted to give less knowledgeable, knowledgeable, and highly knowledgeable groups, respectively (Johnson & Bastian, 2007).

3. Results and discussion

3.1.Study 1 – Consumer tasting of wines with varying body and astringency

3.1.1. Influence of mouthfeel on wine liking and emotions

The differences in wine liking by mouthfeel were determined with GLM ANOVA (Fig. 1). Overall, the addition of GSE significantly (p<0.001) decreased the liking of wines, consistent with Bastian et al. (2010). However, there are conflicting reports also in the literature on the relationship between liking and astringency in wine. In a preliminary study, Garnacha and Tempranillo wines produced by fermentation with

additional grape seeds were preferred more than wines without added seeds (Kovac, Alonso, & Revilla, 1995). Addition of seeds or seed extract at different steps of the vinification process e.g. during or after ferment, may alter polyphenolic composition and lead to differences in how the wines feel and consequently, are liked. Studies such as this with white wines are still lacking. Gum, unlike GSE, overall had no influence on liking. Little is currently known about the influence of perceived body on consumers liking of wines. While there are suggestions of links between consumer liking and viscosity in dry white wine (Francis et al., 2010), this was not the case in the current study.

Differences in emotions evoked by the two mouthfeel agents were analysed. The addition of GSE significantly changed 11 emotion terms (Fig. 2), where it had decreased the intensity of positive emotions while it increased the intensity of negative emotions. The wine with GSE led to a large decrease in "calm" and "relaxed" emotions, while increasing the "irritated" emotion compared to the control. The emotions were closely related to liking, where higher liking ratings were generally associated with more positive emotions and vice versa with disliking and negative emotions, consistent with literature (Jiang et al., 2016).

The addition of Gum did not influence consumers' emotions, which aligned with the lack of change in liking ratings. The results of the current sensory study on perception of intrinsic wine attributes however was not in agreement with Australian consumer's self-reported preference for medium to full bodied wines (Bruwer, Saliba, & Miller, 2011). There are several possible explanations for the lack of effects seen in the current study; either 0.5 g/L xanthan gum in wine was insufficient to give a perceptually distinct sensation from control wine for consumers, or the addition of gum

could be detected by the consumers but it did not have the ability to change consumers' emotion and liking. Given that during the preliminary testing, experienced judges indicated a perceived difference in body at 0.35 g/L (n=30) and more gum was added for the consumer trial to ensure a noticeable difference, the latter explanation seems to be more plausible. The minimum concentration of xanthan gum required to elicit a perceivable difference in viscosity is 0.141 Pa s, an equivalent of 0.04 g/L in white wines made with Thompson seedless (Noble & Bursick, 1984). At the current state of the art, there is little evidence of the direct influence of body on wine preference and emotions felt during wine consumption and knowledge of consumers' understanding of wine body is still lacking.

The lack of effect of gum added to wine on liking and emotions may stem from how consumers understood wine body. In comparison, it has been shown that flavour characteristics have a large influence on liking and emotions in wine (Danner et al., 2016; Jiang et al., 2016) and perhaps is more important for consumers' subjective responses than the mouthfeel of wine body.

3.2 Study 2 – Consumer survey

3.2.1 Ranking of important wine attributes in relation to wine purchase decision

Consumers indicated that "Wine flavour" was significantly (p<0.001) ranked the most important descriptor when choosing a wine for purchase, with production process being significantly least important (Fig. 3). "Wine body" was also highly important, being ranked third on the list. It was not significantly different in importance from "balance of flavours" and "wine's ability to match food". Therefore, wine body

was one of the five most helpful descriptions on a bottle when choosing a wine for purchase.

3.2.2 Consumers' definition of "Wine body"

Approximately half of the consumers indicated their use of the word "*body*" to describe wine (49 % as Yes and 51 % as No). Consumers on average used two terms to define body in the open-ended question. Over one third of the consumers used the term "*Flavour"* to define wine body, which was the most frequently used term, followed by "*Fullness"*, "*Strength"*, "*Taste*", "*Light*", and "*Mouthfeel*", all above 15 % of all citations (Table 1). Other terms that were cited that appeared to be mouthfeel related were; thickness, thinness, and viscosity, ranging between 11 % and 6 %. A small percentage of consumers (8.1%) used examples of "*Wine style"* to support their definition of wine body. A portion of the consumers (11%) were not able to define wine body.

The scores of the content analysis further segmented by subjective knowledge showed an overall agreement in the use of the words "*Flavour*" and "*Fullness*" to define wine body by all segments (Fig. 4). A trend across knowledge segments was seen specifically for descriptions that relate to texture, where "*mouthfeel*", "*thickness*", and "*depth*" were cited more with increasing subjective knowledge. These textural terms are typically expressed by experts and used in assessing wine body (Gawel, Smith, & Waters, 2016; Nurgel & Pickering, 2005; Pickering, Heatherbell, Vanhanen, & Barnes, 1998). This suggested that highly knowledgeable consumers are more likely to use textural terms to describe wine body, possibly as a result of their frequent exposure to and learning about wines, leading to better articulation of sensory descriptors. Consumers with greater subjective knowledge (and as a result greater objective

knowledge (Johnson & Bastian, 2007)) are more likely to access different sources of information for wine, including published material such as books and magazines as well as personal memory (Dodd, Laverie, Wilcox, & Duhan, 2005). Contrary to expectation, there was a higher proportion of knowledgeable consumers who were unsure in describing wine body than the other knowledge segments. It is worth noting, that aficionados or knowledgeable consumers are more susceptible to verbal overshadowing than less knowledgeable individuals or experts, that is, verbal description of a perception is overemphasised over the memory of the actual perception (Melcher & Schooler, 1996). The result is a distortion in memory and hence the accuracy of the verbal description only in the knowledgeable consumers who are highly involved in wine but lack the formal training (Latour & Latour, 2010). This effect requires further investigation in contexts such as defining wine body.

"*Flavour"* was one of the main characteristics of wine body from the consumer's point of view. In general, wines that are full bodied are more intense in flavour and vice versa. Consumers used terms such as "*Taste"*, "*Mouth"* and "*Palate"* in combination with other adjectives that appeared to capture the holistic sensation of wine that would occur during consumption. Examples were; *"It has good fruity quality on the palate", "Full taste on all of palate", "The depth of taste in your mouth",* and *"Full flavour that lingers in the mouth after swallowing"*. This is not surprising as consumers often link multisensory flavour sensations to the oral cavity due to its seemingly unitary percept (Small, 2008), in particular when the flavour components are harmonious with each other (Lim & Johnson, 2011). Regular wine consumers are also known to confuse perceptions that often occur together such as astringency with bitterness and sourness (Lee & Vickers, 2008; Lesschaeve & Noble, 2005) or even use textural words that have

additional meaning other than texture (Szczesniak & Skinner, 1973). To add to this, consumers spontaneously mentioned an average of two terms in their definition of wine body, a limited and general vocabulary. This was in concordance with the findings for astringency (Vidal et al., 2015).

As consumers had been selected based on their Australian citizenship or residency to obtain vocabulary unique to regular Australian wine consumers, similar work conducted in other countries and languages could lead to different findings. Diverse wine cultures across countries may influence the degree of vocabulary used to describe wine body by consumers and also how much the product is ingrained into that culture. French consumers' understanding and description of the concept of "Fatness" and "Fullness" in wine, gave descriptions such as "Presence in the mouth", "Aftertaste", "Round", "Wide", "Strong", "Thick", "Heavy", "Oily" and "Round" (Le Fur et al., 2011). In particular, the understanding of "Fatness" by French consumers were centred on texture and hedonics, while "Fullness" was more global. Although the terms "Strong", "Thick" and "Oily" were used in common by French and Australian wine consumers, "fatness" and "wide" were not mentioned by Australians. Conversely, "Flavour" was not mentioned by French wine consumers (Le Fur et al., 2011). It is tempting to deduce that Australians overall have a poorer understanding of this particular mouthfeel sensation, however the terms "fatness" and "body" cannot be taken as a direct substitute for each other. Thus, the results of the current study only extend to the general wine consuming population of Australia and further studies are required to confirm results, at the very least, in other countries with English as the primary language. This applies to the previously reported understanding of astringency by

Uruguayan consumers' (Vidal et al., 2015) and a study on Australian consumers would be required to determine how astringency is understood in Australia.

The major implication of these results for industry is that one cannot assume that consumers have an in depth understanding of wine body, especially given that only a fraction of the participants used terms that specifically related to texture. The consequence of this is potentially miscommunication resulting in disappointment felt by consumers, and finally a decrease in product interest and purchase intent due to a contrast in expectations (Wansink & Park, 2002). A better understanding of how consumers understand wine body as a sensory percept will lead to an enhanced ability for the industry to communicate wine sensory characteristics to the general public (Lawless & Civille, 2013). It is suspected that this would also be the case for other beverages such as beer and cider, where "body" is used to describe part of its sensory characteristics.

3.2.3 Associated level of body by wine type

Consumers classified red and white wines commonly found in Australia into three levels of body (light, medium, and full) (Fig. 5). White wines (*Riesling, Chardonnay, Sauvignon Blanc* and *Semillon*) were mainly associated with either low or medium body. On the other hand, consumers appeared to be more certain of the associated level of wine body for red wines. The majority of consumers considered Shiraz/Syrah and Cabernet Sauvignon as full bodied, while Grenache, Pinot Noir, and Merlot as medium bodied. White wines may have been comparatively more difficult to associate with a specific level of body than red wines. In addition, a vast number of consumers

considered Rosé and Sparkling white wine/Champagne as light bodied wine. In particular, Rosé was considered lighter bodied than white wines such as Riesling, Chardonnay, and Semllion, indicating that for light coloured wines, associations other than colour may have driven the categorisation of wine body. Exactly which type of associations were responsible for consumers to indicate their choice is currently unknown and should be tested further in future studies. The Tawny/port wines were considered to be a full-bodied wine by most of the consumers. How these results compare to literature is challenging to determine due to complete lack of scientific studies. Similar to the lack of wine body definitions in literature, there are no clear definitions or prerequisites to the categorisation of wines by levels of body. Exactly how wines are categorised into levels of wine body requires further investigation.

3.3 Limitations

A limitation of study 1 was the assumption that consumers have a clear understanding of body in the context of wine, due to previous literature reporting its relative importance to wine hedonics. This is in stark contrast to wine astringency, where there was a relatively homogenous understanding of the mouthfeel among consumers (Vidal et al., 2015) as well as the current study demonstrating that overly astringent wines are less preferred. Also, it is not certain whether the consumers could differentiate the mouthfeel of wine with added gum from the control wine. A study that would ascertain the consumers' ability to perceive a difference in body coupled with rheology would be of great benefit. An investigation on commercial wines with a wide range of viscosities, followed by its influence on liking would clarify the overall contribution of "*wine body*" from an oenological stand point. It is also possible that providing consumers a context for the assessment of wine liking and emotions, such as

informing the consumers about the wine style e.g. light/medium/full bodied or wine variety, may have provided greater discrimination as a function of gum addition. This is worth further investigation, as discrimination between consumers' hedonic responses are potentially increased with contextual information (Hein, Hamid, Jaeger, & Delahunty, 2010, 2012; Piqueras-Fiszman & Jaeger, 2014a, 2014b). It is worth noting that in study 2, although results showed that consumers interpreted "wine body" as a holistic flavour percept, it is unknown whether the level of body is driven by any single attribute in wine or that it is indeed driven by overall flavour intensity; this warrants further study. Given that the consumers stated, "balance of flavour" was the second most important wine character following wine flavour, future studies should investigate how balance of flavours and the perception of "balance" influences wine hedonics.

4. Conclusions

Wine mouthfeel influenced consumers' liking and elicited emotions. Addition of GSE resulting in the increased astringency, in particular determined the degree of liking of wines and subsequently to shifts in both positive and negative emotions. Gum on the other hand was not a critical factor for liking and emotions. With this, the study showed that emotions relate closely to liking, where positive emotions are expected to reflect samples that are liked and vice versa. Although half of the consumers reported they frequently use the word "body" to describe wine in their everyday lives, the general understanding that constitutes the concept of wine body was not textural. Rather it reflected holistic flavour perception and overall magnitude of intensity. In addition, consumers' vocabulary to describe wine body was very limited. Therefore, consumer and industry education is required if the wine industry attempts to communicate sensory

characteristics of wines to the consumers. It is expected that this would also be required for other types of beverages, given that the concept of body is so broad. Further research is required to explore the relationship between wine involvement of consumers and their ability to describe wine body. Moreover, studies should determine the importance of each sensation (according to consumers) in detail that seem to be part of wine body, especially flavour intensity. The perception and the description of wine body during the consumption of wine by regular wine consumers should also be investigated.

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Table 1. Percentage of the word categories mentioned in the open-ended question "How would you describe wine body?" (n = 136).

Categories	**Examples**	**Citation (%)**
Flavour	Flavour; Flavor	37.5
Fullness	Full; Fullness	32.4
Strength	Strong; Strength	24.3
Taste	Taste	20.6
Light	Light	16.2
Mouthfeel	Mouthfeel; feel in the mouth	16.2
Heaviness	Heavy; heaviness	11.0
Mouth	Mouth	11.0
Thickness	Thick; thickness	8.8
Richness	Rich; Richness	8.1
Wine style	Red wine; Shiraz	8.1
Depth	Deep; depth	7.4
Thinness	Thin; thinness	7.4
Viscosity	Viscous; viscosity	6.6
Unsure	I don't know; unsure	11.0

Figure Legends:

Figure 1. Mean (± S.E.) liking ratings (n=112) of wine samples with added mouthfeel agents measured on 9-point hedonic scale. Means with the same superscripts are not significantly different according to Bonferroni corrected post-hoc comparisons.

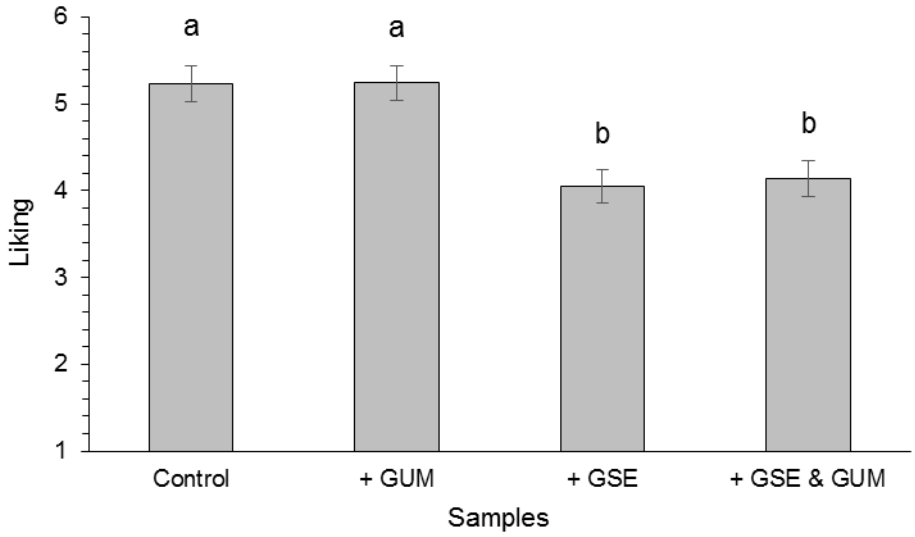
Figure 2. Means of significantly different emotion intensities (n=112) for control (solid black line), wine with gum (broken black line), wine with GSE (solid grey line), and wine with both gum and GSE (broken grey line). *** = $p<0.001$, ** = $p<0.01$, and * = $p<0.05$.

Figure 3. Rank sums (n=136) of the importance to consumers of concepts in relation to wine purchase. Rank sums that share the same superscript are not significantly different according to Friedman's test.

Figure 4. Content analysis of terms important to describe wine body separated by subjective knowledge of wine consumer groups (less knowledgeable n = 34, knowledgeable n = 68, highly knowledgeable n = 34).

Figure 5. Consumer association of level of body with each type of wine (n=136).

List of Figures



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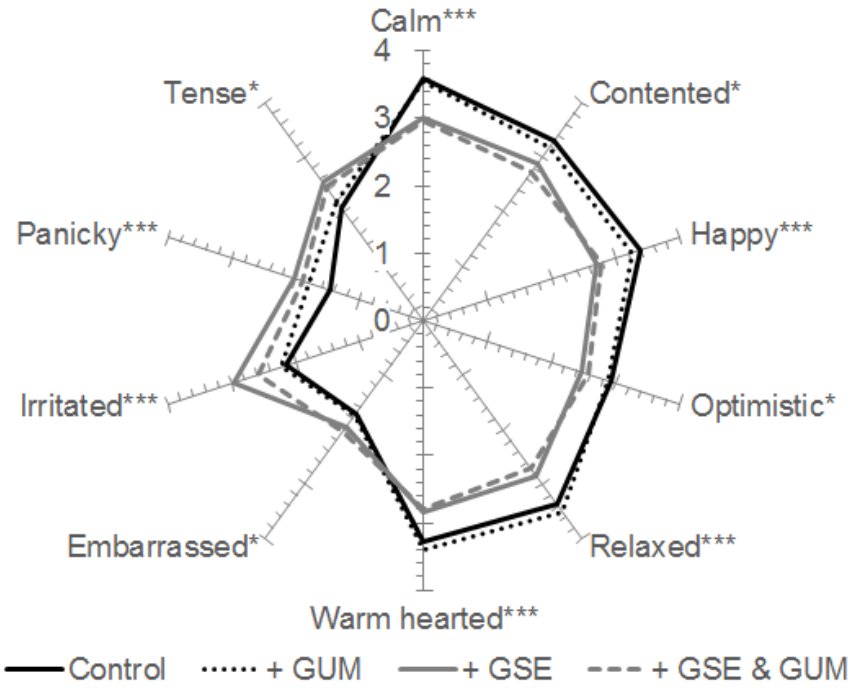

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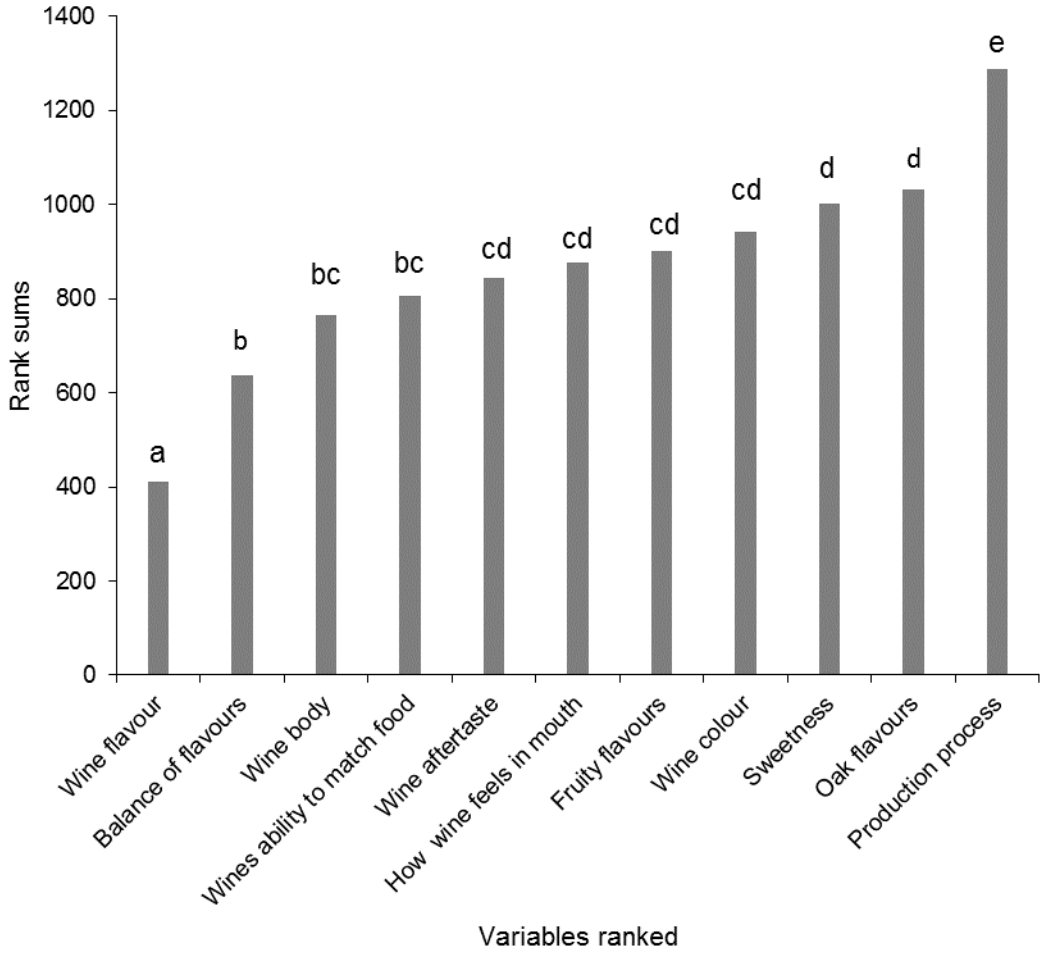

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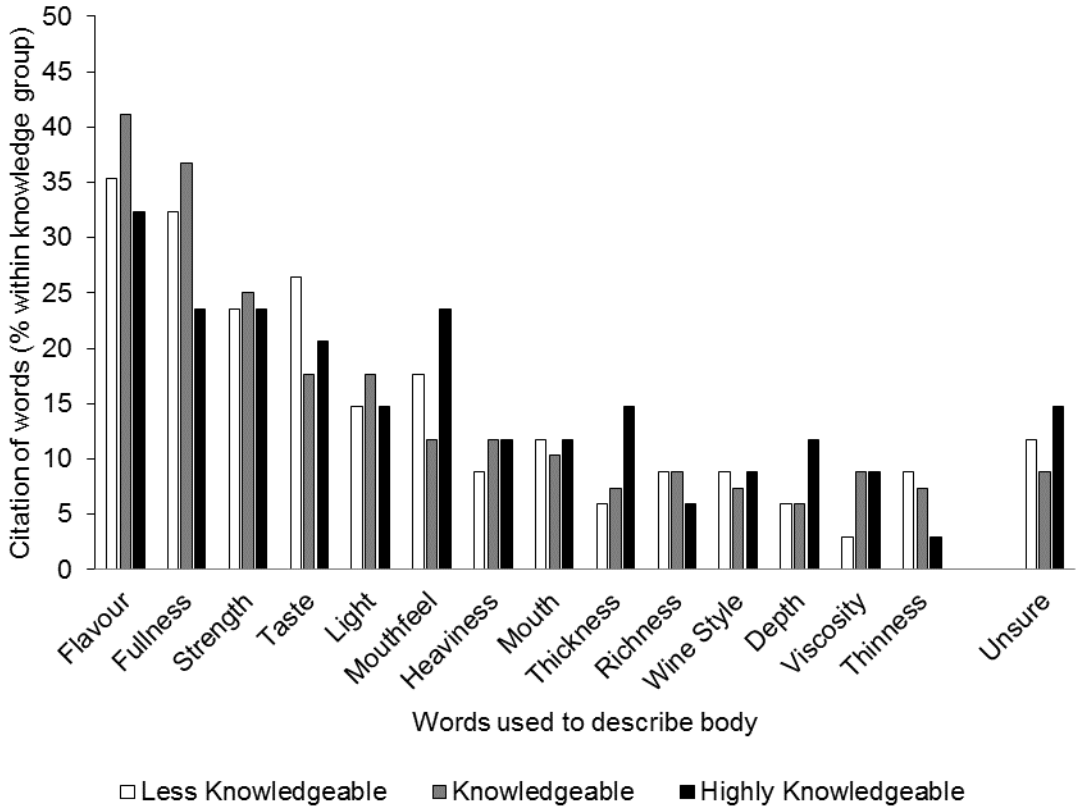

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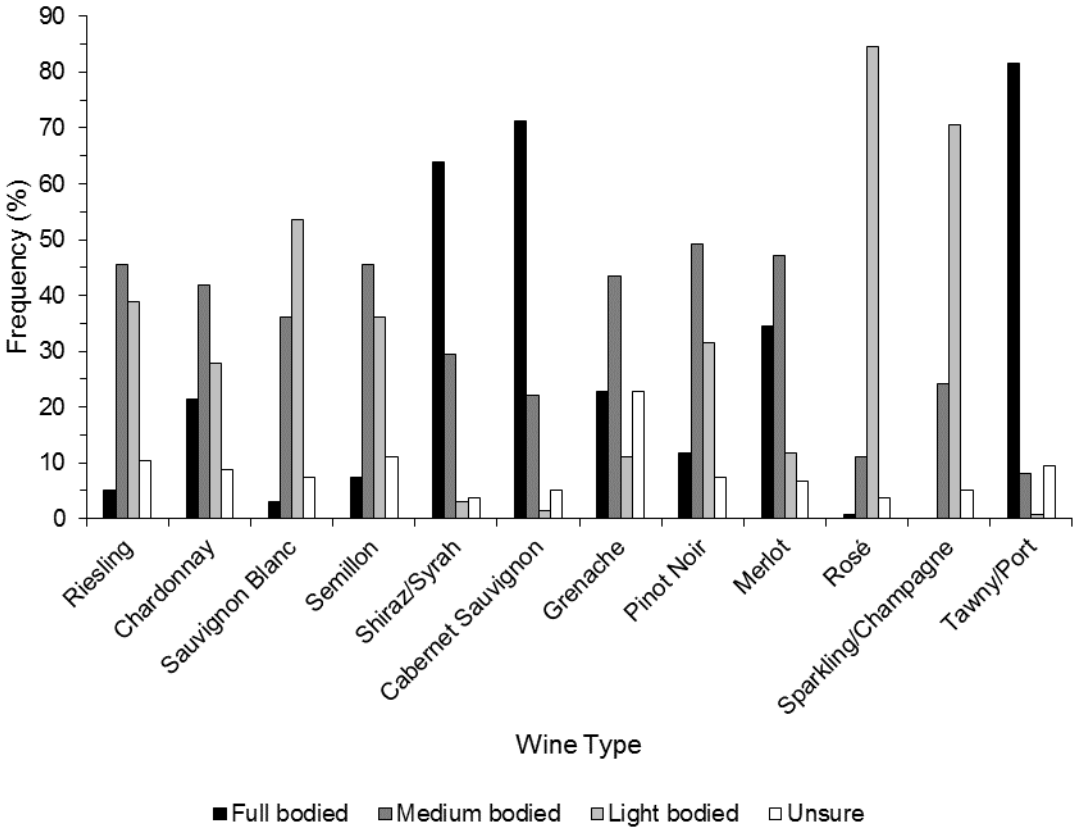

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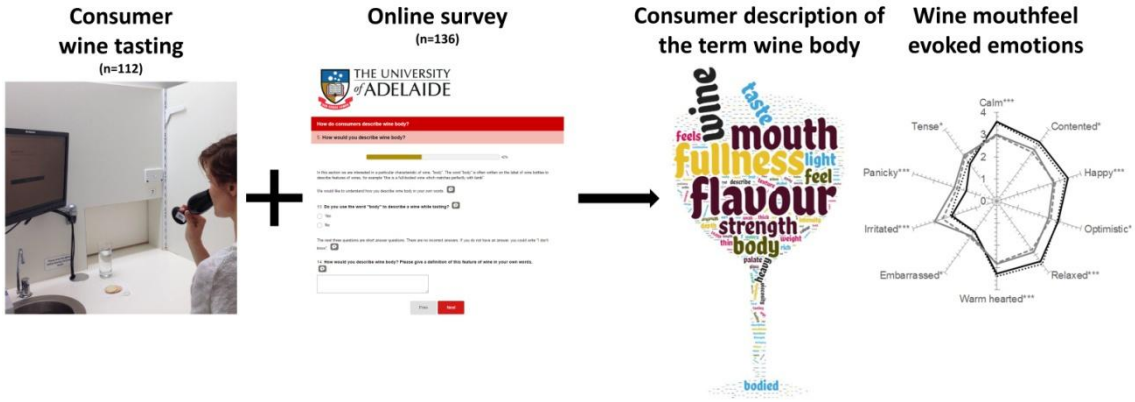

Graphical abstract

Highlights:

- Changes in astringency of wine was a determinant in consumers liking and emotions
- Increases in body by addition of gum had no influence on consumers liking or emotions
- Wine body was understood by consumers as a holistic perception of flavour and intensity, not only mouthfeel