

Figure 3.4.1 PCA biplot of the sensory profile of six chocolate mousse products (M1-M6) on the first two principal components (PC)- PC1 and PC2

As expected, there was a positive linear relationship between cocoa aroma and flavour, earthy flavour and brown colour. These indicate that the brown colour and earthy flavour may be due to the cocoa or chocolate concentration in the sample. In some cases, the addition of a colouring agent contributes to the intensity of the colour; colouring agents were added to two of the chocolate mousses evaluated in this study- M4 and M2. A negative correlation was observed between the cocoa aroma and flavour intensity and the milk aroma and flavour intensity. This is expected as the intensity of the cocoa flavour is reduced by the addition of milk resulting in an inverse relationship. There was a positive correlation between milk aroma, milk flavour and aeration. There was a positive correlation between mouth coating and gloss. This is expected as both properties are related to the fat content and/or chocolate content of *the mousse* (Pastor et al., 2007).

3.4.3.2 Instrumental colour evaluation

The chocolate mousses were characterised by a mixture of redness and yellowness as revealed by positive a^* and b^* values (Table 3.4.4). As expected, their lightness (L^*) was more towards the black region than the white region, sample M6 was the lightest (50.86), while sample M4 was the

darkest (36.69). The range of $L^*a^*b^*$ values obtained in this study was similar to those obtained for chocolate milk (Thompson et al., 2004) and dark chocolate (Machalkova et al., 2014) in previous studies. The target chocolate mousse had medium lightness compared to the other samples.

There was a significant difference between the chocolate mousses for all the colour parameters measured (Table 3.4.4). The colour difference between the mousses ranged from 1.76 (only noticeable to the experienced observer) to 14.35 (perceived as different colours). Samples M3 and M6 which had the lowest colour difference ($\Delta E = 1.76$). The difference between all other pairs was > 2 and may therefore be noticeable to consumers (Gaze et al., 2015a, Mokrzycki and Tatol, 2011). Consumers may choose to consider colour when judging product quality during selection. The difference in colour between samples M1 and M2 was distinct and noticeable to the inexperienced observer, with the latter being lighter in colour. This may be an indication of inconsistent product quality, or that storage and distribution conditions have made sample M2 lighter with time. The impact of the storage conditions is not clear. However it may be related to changes in the microstructure of the product, as light scattering by protein and fat particles affect the lightness of dairy products (Park et al., 2015). This highlights the importance of storing chocolate mousse under optimal conditions to prevent undesirable changes in the colour and other characteristics of the product.

Table 3.4.4 The mean values for the instrumental colour parameters ($L^*a^*b^*$) and the colour difference (ΔE) between the chocolate mousse samples

Product	M1	M2	M3	M4	M5	M6
L*	44.91 ^b	47.05 ^{bc}	49.23 ^{cd}	36.69 ^a	38.96 ^a	50.86 ^d
a*	12.00 ^{bc}	11.67 ^{ab}	11.57 ^{ab}	12.25 ^{cd}	11.29 ^a	11.78 ^{abc}
b*	15.33 ^{cd}	15.49 ^d	13.43 ^b	11.81 ^a	11.97 ^a	14.05 ^{bc}
	M1	2.17	4.74	8.95	6.87	6.09
	M2		3.00	11.01	8.83	4.07
ΔE	M3			12.66	10.38	1.76
	M4				2.47	14.35
	M5					12.09

Mean values on the same row for $L^*a^*b^*$ values with different superscripts, differ significantly ($P < 0.05$).

Table 3.4.5 Correlation between the intensity of the sensory attributes obtained by the trained panel and L*A*B* values obtained by instrumental colour analysis of the chocolate mousses

Variables	Cocoa Aroma	Milk Aroma	Brown Colour	Gloss	Aeration	Smoothness	Sweetness	Bitterness	Milk Flavour	Earthy	Vanilla	Cocoa Flavour	Bitterness	Astringent	Mouth-coating	L*	A*	B*
Cocoa aroma	1	-0.947	0.975	0.667	-0.885	-0.960	-0.102	0.899	-0.968	0.962	-0.828	0.986	0.919	0.850	0.787	-0.951	-0.065	-0.622
Milk aroma	-0.947	1	-0.956	-0.708	0.920	0.925	0.063	-0.916	0.962	-0.991	0.867	-0.968	-0.948	-0.928	-0.794	0.931	-0.012	0.636
Brown colour	0.975	-0.956	1	0.663	-0.904	-0.950	-0.148	0.925	-0.981	0.981	-0.861	0.968	0.947	0.868	0.734	-0.989	0.146	-0.604
Gloss	0.667	-0.708	0.663	1	-0.914	-0.508	0.638	0.405	-0.790	0.730	-0.271	0.656	0.477	0.424	0.938	-0.730	-0.012	-0.991
Aeration	-0.885	0.920	-0.904	-0.914	1	0.781	-0.271	-0.737	0.967	-0.942	0.630	-0.888	-0.789	-0.728	-0.919	0.935	-0.100	0.868
Smoothness	-0.960	0.925	-0.950	-0.508	0.781	1	0.290	-0.920	0.899	-0.922	0.900	-0.937	-0.936	-0.877	-0.617	0.898	0.057	0.458
Sweetness	-0.102	0.063	-0.148	0.638	-0.271	0.290	1	-0.431	-0.039	-0.053	0.549	-0.123	-0.359	-0.364	0.491	0.047	-0.213	-0.698
Bitterness	0.899	-0.916	0.925	0.405	-0.737	-0.920	-0.431	1	-0.865	0.918	-0.982	0.935	0.995	0.972	0.556	-0.873	0.134	-0.314
Milk flavour	-0.968	0.962	-0.981	-0.790	0.967	0.899	-0.039	-0.865	1	-0.986	0.776	-0.965	-0.899	-0.827	-0.848	0.987	-0.096	0.738
Earthy	0.962	-0.991	0.981	0.730	-0.942	-0.922	-0.053	0.918	-0.986	1	-0.852	0.976	0.948	0.904	0.806	-0.969	0.089	-0.662
Vanilla	-0.828	0.867	-0.861	-0.271	0.630	0.900	0.549	-0.982	0.776	-0.852	1	-0.865	-0.972	-0.968	-0.419	0.789	-0.125	0.175
Cocoa flavour	0.986	-0.968	0.968	0.656	-0.888	-0.937	-0.123	0.935	-0.965	0.976	-0.865	1	0.951	0.910	0.799	-0.939	-0.043	-0.594
Bitterness	0.919	-0.948	0.947	0.477	-0.789	-0.936	-0.359	0.995	-0.899	0.948	-0.972	0.951	1	0.975	0.607	-0.901	0.128	-0.389
Astringent	0.850	-0.928	0.868	0.424	-0.728	-0.877	-0.364	0.972	-0.827	0.904	-0.968	0.910	0.975	1	0.580	-0.806	0.042	-0.322
Mouth-coating	0.787	-0.794	0.734	0.938	-0.919	-0.617	0.491	0.556	-0.848	0.806	-0.419	0.799	0.607	0.580	1	-0.767	-0.195	-0.916
L*	-0.951	0.931	-0.989	-0.730	0.935	0.898	0.047	-0.873	0.987	-0.969	0.789	-0.939	-0.901	-0.806	-0.767	1	-0.223	0.677
A*	-0.065	-0.012	0.146	-0.012	-0.100	0.057	-0.213	0.134	-0.096	0.089	-0.125	-0.043	0.128	0.042	-0.195	-0.223	1	0.066
B*	-0.622	0.636	-0.604	-0.991	0.868	0.458	-0.698	-0.314	0.738	-0.662	0.175	-0.594	-0.389	-0.322	-0.916	0.677	0.066	1

Values displayed in bold are significant (P<0.05)

As expected, there was a negative correlation between the intensity of the brown colour perceived by the trained panel and the instrumental colour parameters L* ($r = -0.989$) and b* (-0.636) (Table 3.4.5). The relationship between the colour from the trained panel and L* and b* values is similar to previous results obtained by Thompson et al. (2004). There was also a strong negative correlation between L* and cocoa aroma ($r = -0.951$) and cocoa flavour ($r = -0.939$) (Table 3.4.5). While there was a strong positive relationship between L* and milk aroma ($r = 0.931$) and milk flavour ($r = 0.987$). A similar, however moderate relationship was observed between b* and cocoa aroma (-0.622), cocoa flavour (-0.594), milk aroma (0.636) and milk flavour (0.738). This strongly suggests a causal link between the cocoa and milk concentrations and the colour of the chocolate mousse. The a* values did not correlate significantly with any of the sensory attributes.

3.4.3.3 Consumer liking

There were significant differences ($P < 0.0001$) in the overall liking of the chocolate mousses by consumers (Table 3.4.7). The mean liking ratings ranged from 4.64 to 7.33, indicating that the chocolate mousses were generally liked. Data from one consumer was not included as they gave the same rating for all products, so the data may not contribute to understanding the drivers of product preference (Arditti, 1997; Liggett, 2011). Pairwise comparison of the overall liking of the mousses by all consumers resulted in three groups of products- M3 and M6 were the most preferred mousses (group 1), M4 was moderately liked (group 2), and M5 was least preferred (group 3). M2 (the target product) overlapped between groups 2 and 3 and was moderate to least liked (Table 3.4.7).

Table 3.4.6 Mean overall liking of the chocolate mousses by consumer clusters using a 9 pt hedonic rating scale (1- dislike extremely to 9 like extremely)

Consumers	n	M3	M4	M2	M5	M6
All	78	7.08 ^a	6.01 ^b	5.28 ^{bc}	4.64 ^c	7.33 ^a
Cluster 1	32	8.13 ^a	7.34 ^a	6.03 ^b	5.56 ^b	7.97 ^a
Cluster 2	22	6.86 ^a	3.73 ^b	6.32 ^a	3.73 ^b	7.68 ^a
Cluster 3	24	5.88 ^{ab}	6.33 ^a	3.33 ^c	4.25 ^{bc}	6.17 ^a

Mean values on the same row with different superscripts are significantly different ($P < 0.05$).

Cluster analysis resulted in three consumer clusters (Figure 3.4.2). Cluster 1 (C1) consisted of 32 consumers, cluster 2 (C2) had 22 consumers, while cluster 3 (C3) had 24 consumers. All three clusters had different preference patterns, as revealed by the results of the ANOVA (Table 3.4.5). Consumers in cluster 1 liked all the chocolate mousses. There were however significant differences between the overall liking rating for the different products. These suggest that consumers in C1 did not distinguish well among the different products (Bernstein, 2015). Consumers in C2 liked the products with higher intensities of vanilla and milk flavour. In comparison, consumers in C3 liked M4 and M6, which were characterised by moderate sweetness and thickness (Figure 3.4.1).

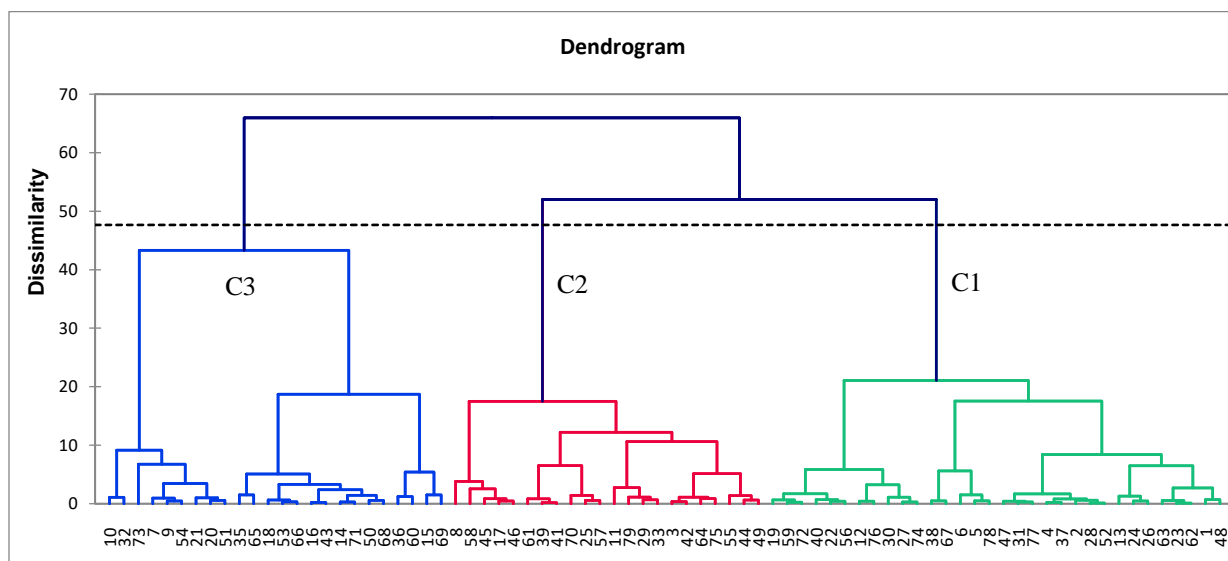


Figure 3.4.2 Dendrogram of consumer segmentation by hierarchical clustering based on their overall liking ratings of the chocolate mousse. C1, C2, C3 represents cluster 1, 2 and 3, respectively

Analysis of consumer free comments resulted in twelve groups of sensory attributes (Table 3.4.7). Two categories- mouthcoating and aftertaste were removed as less than 5% of consumers described sensory perceptions related to it. Chi-square (χ^2) test of association was significant for both the like ($\chi^2 = 56.2$, $df = 4$, $p = 0.048$) and dislike comments ($\chi^2 = 70$, $df = 4$, $p = 0.019$) for the products, revealing that consumers used a different number of comments to describe liking and disliking of the products (Sharma et al., 2019).

Table 3.4.7 Frequency table of count of like (L) and dislike (D) comments for each mousse

Comment group	M2	M3	M4	M5	M6	% ^a
Like comments						
L_look	2	6	5	6	5	4.1
L_smell	1	2	3	1	0 (-)	1.2
L_aeration	9	26 (+)	2 (-)	4 (-)	28 (+)	11.9
L_texture	14	12	16	6	1	10.7
L_smooth	14	10 (-)	14	17 (+)	18	12.6
L_chocolate	17	22	29	16	26	19.0
L_flavour	14	30	14	12	26	16.6
L_sweet	16	22	18	10	25	15.7
L_bitter	1	1	1	0 (-)	0 (-)	0.5
L_aftertaste	1	2	2	2	3	1.7
L_hedonic	4	10	8	5	8	6.0
Dislike comments						
D_look	7	4	2	3 (-)	5	5.4
D_smell	1	0 (-)	2	5	2	2.6
D_aeration	2 (-)	2	9	8	2	6.0
D_texture	12	7	21	24	5	17.9
D_smooth	3	4	5	8	0 (-)	5.2
D_chocolate	16	13	17	21	9	19.7
D_flavour	22 (+)	5	9	20	5	15.8
D_sweet	9	11 (+)	10	8 (-)	8	11.9
D_bitter	3	0 (-)	4	7	0 (-)	3.6
D_aftertaste	13	2	7	14	3	10.1
D_hedonic	3	0 (-)	0 (-)	4	0 (-)	1.8

Values displayed in bold font indicate that the observed frequency is significantly different (higher +, lower -) than the expected theoretical frequency. ^a - Percentage of mentions for the sensory descriptor in comparison to the total number of like and dislike comments.

Chocolate flavour, non-chocolate flavour and sweetness received the highest count for product liking comments, while chocolate flavour, non-chocolate flavour and texture received the highest count for product disliking comments (Table 3.4.7). This indicates the importance of chocolate flavour and flavour in general to consumer preference for chocolate mousse. Despite the variance in the number of comments for like/ dislike of chocolate flavour, there was no significant

difference in the expected and observed frequencies for the different products. The insignificant difference may be an indication that consumers varied widely on their preferred intensity of chocolate flavour. The chocolate flavour intensity for three of the products (M3, M4, M6) was generally liked than disliked, as evidenced by the higher frequency of like comments compared to dislike. While similar frequencies of like and dislike comments were observed for M2, M5 had a higher number of dislike comments compared to like comments (Table 3.4.7). Comments on the liking of the aeration of the products followed a similar pattern as the average overall liking. The two most-liked products had a significantly higher observed frequency than expected, while the two least-liked products had significantly lower observed frequency. These trends may be an indication that aeration is a driver of liking. A similar trend was observed in a previous study on consumer preference of apples (Symoneaux et al., 2012).

Overall, look, smell, and bitterness received the lowest counts for both liking and disliking comments. This may be an indication that these attributes were not important drivers of consumer preference. There was no significant difference in the expected and observed frequencies of like/dislike comments on look, smoothness and hedonic categories.

3.4.3.4 Drivers of liking using PLS regression

The PLS regression of the average liking of the three clusters of consumers on the average intensity of the 17 sensory attributes resulted in a model with four components. The model was automatically selected by using the default method in XLSTAT- Jack-knife (leave-one-out) and the predictive residual sum of squares (PRESS) criterion. The criterion which is commonly used selects the number of components that give the minimum prediction error. This criterion has however been criticised to favour overfitting (selection of too many components) (Deng et al., 2015, Gómez-Carracedo et al., 2007). All model fit indices- Q^2 cumulated index (Q^2 cum), variance of consumer liking explained (R^2Y cum), and the variance of panel sensory data explained (R^2X cum) attained the maximum value (1) for the model with four PLS components (Table 3.4.7). The resulting correlation circle for descriptive sensory data and consumer liking data is shown in Figure 3.4.3.

Table 3.4.8 PLS regression statistics for the four-component model selected by XLSTAT and that of the model selected based on the Q² index for each consumer cluster (C1, C2, and C3)

Statistic	All clusters (C1- C3)				C1	C2	C3		
	Com1	Com2	Com3	Com4	Com1	Com1	Com1	Com2	Com3
Q ² cum	0.384	0.676	0.904	1.000	0.439	0.892	-0.045	0.200	0.906
R ² Y cum	0.537	0.835	0.984	1.000	0.649	0.937	0.487	0.759	0.996
R ² X cum	0.780	0.979	0.987	1.000	0.767	0.781	0.615	0.979	0.988

Com- component

The PLS regression was rerun for each consumer cluster separately to improve the precision of the PLS model (Tenenhaus et al., 2005), the optimal number of components indicated by the maximum Q² and R² indices was used (Liggett, 2010). This resulted in one component for clusters C1 and C2 and three components for C3. It is noteworthy that when the PLS regression was rerun for individual clusters, XLSTAT automatically selected the same number of components indicated by the Q² index for C1 and C2 but still retained the four components for C3. A model with three components was forced. The selection of variables after PLS is an important step in reducing a large number of predictor variables (sensory attributes) to a smaller number of relevant variables that best explain the variance in the response variable (consumer liking) (Farrés et al., 2015). For individual clusters of consumers, the important sensory attributes that drive liking were identified as those with variable importance for the projection (VIP) greater than 0.8 and where the standard deviation of its standard coefficient does not cross the y axis (Janiaski et al., 2016). The standard coefficient also depicts the direction (positive or negative) of the influence of the sensory attribute on consumers liking.

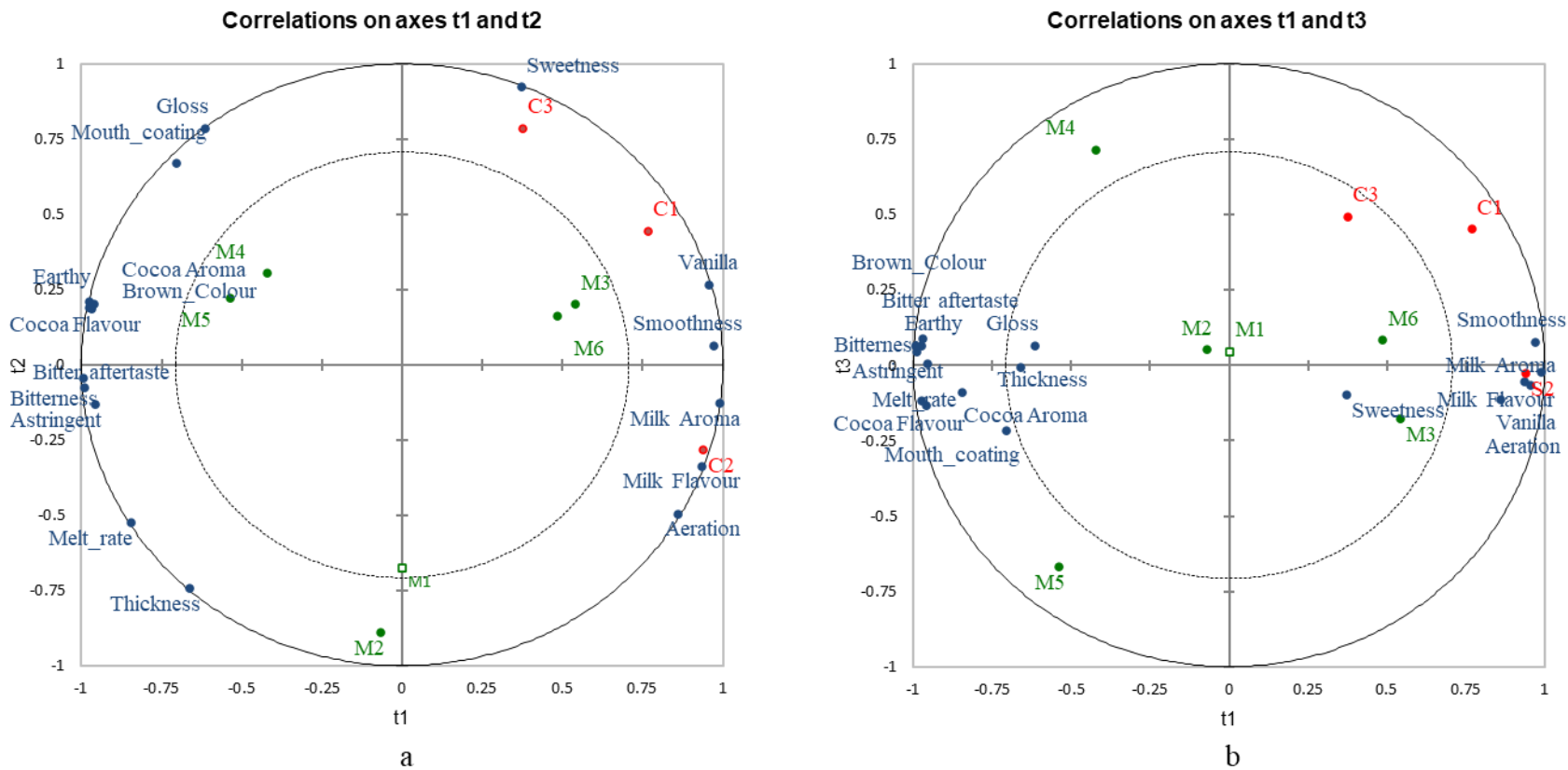


Figure 3.4.3 Correlation circle of the sensory attributes (blue), the overall liking of the consumer clusters (red) and the products (green) on two PLS components t1 and t2 (a) and t1 and t3 (b)

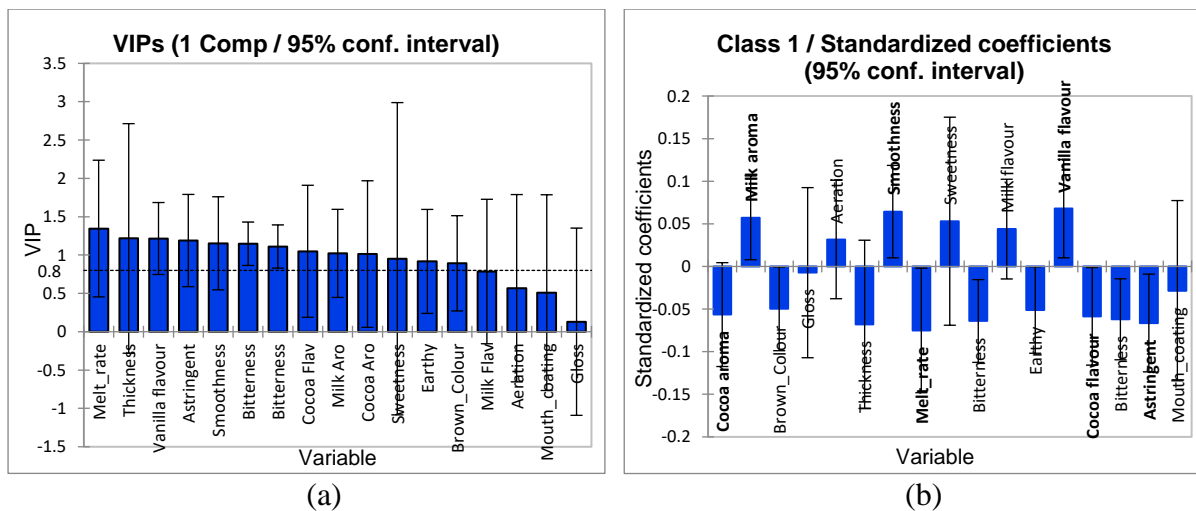


Figure 3.4.4 (a) Variable importance for the projection (VIP) and (b) regression coefficients of all attributes for cluster 1. Attributes with VIP greater than 0.8 are important drivers of liking/disliking

The quality of the regression for the one-component model for C1 showed a poor fit as indicated by the Q^2 cum index (0.439) (Table 3.4.7). The poor fit of the PLS model for cluster 1 is similar to the model fit obtained in some previous studies (Gaze et al., 2015b, Liggett, 2010). The authors suggested that the poor fit may be an indication of the non-linear nature of the relationship between consumer liking and the sensory data. Consumers in C1 liked all the products despite their different sensory properties; thus, product liking and the sensory attributes may have a non-linear relationship which is not well accounted for by PLS regression (Cariou et al., 2014). The low model fit may also be due to the heterogeneity of the consumers in that cluster (Tenenhaus et al., 2005). For C1, the standard coefficients (Figure 3.4.4b) reveal that drivers of liking were smoothness, vanilla flavour and milk aroma. In comparison, the drivers of disliking were melt rate, cocoa flavour, astringency, bitterness, brown colour and earthy flavour. Four variables- milk flavour, aeration, mouth coating and gloss had a VIP below 0.8 and were not relevant to the preference of chocolate mousse for these consumers.

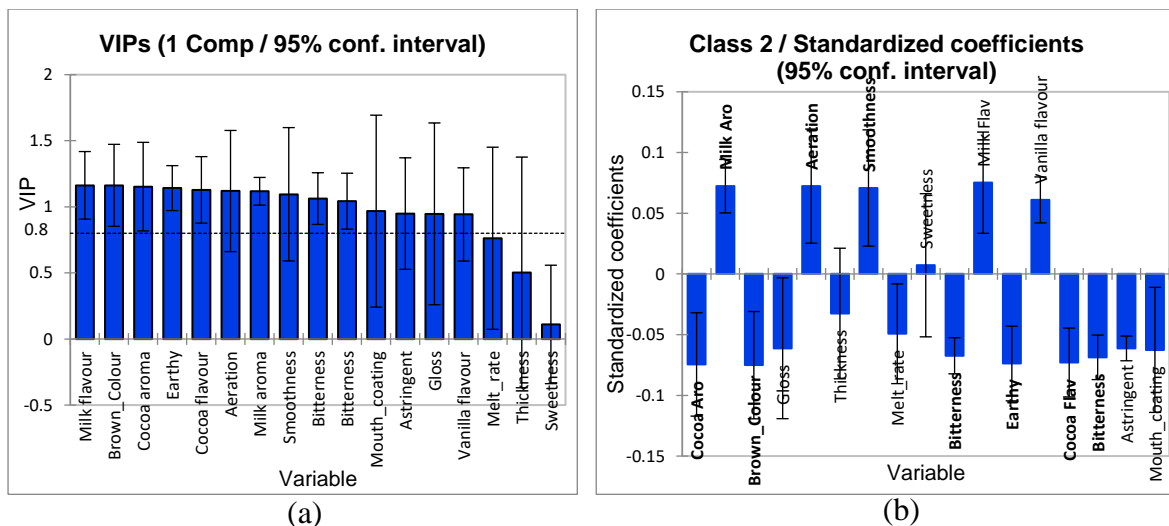


Figure 3.4.5 (a) Variable importance for the projection (VIP) and (b) regression coefficients of all attributes for cluster 2. Attributes with VIP greater than 0.8 are important drivers of liking/disliking

As shown in Table 3.4.8, a good model fit was obtained for C2 (0.892) and C3 (0.906), thus indicating good global goodness of fit and predictive quality (Tenenhaus et al., 2005, Gaze et al., 2015b). While a good R^2Y cum and R^2X cum (typically above 0.5) indicate that the model adequately summarised the dependent and independent data sets (Gaze et al., 2015b). The drivers of liking for C2 were similar to that of C1, while they differed for the drivers of disliking. Product liking for C2 was driven by higher intensities of smoothness, vanilla flavour, aeration, milk aroma and flavour (Figure 3.4.5b). The drivers of disliking were brown colour, cocoa aroma and flavour, bitterness, gloss, mouthcoating and astringency. The VIP scores revealed that melt rate, thickness and sweetness were not relevant to the preference of chocolate mousse for consumers in cluster 2. The irrelevance of thickness is unexpected as texture properties are usually of utmost importance in consumer preference of semisolid milk products (Janiaski et al., 2016).

The drivers of liking for cluster 3 were smoothness and gloss, while drivers of disliking were melt rate, aeration, mouthcoating, cocoa aroma and flavour and thickness (Figure 3.4.6b). Six variables were irrelevant ($VIP < 0.8$) to the preference of C3 consumers, these were bitterness, brown colour, astringent, earthy, milk flavour and milk aroma. The drivers of liking identified in this study are similar to previous studies where flavour, smoothness, colour and viscosity influenced consumer liking of yoghurt products (Janiaski et al., 2016, Masson et al., 2016).

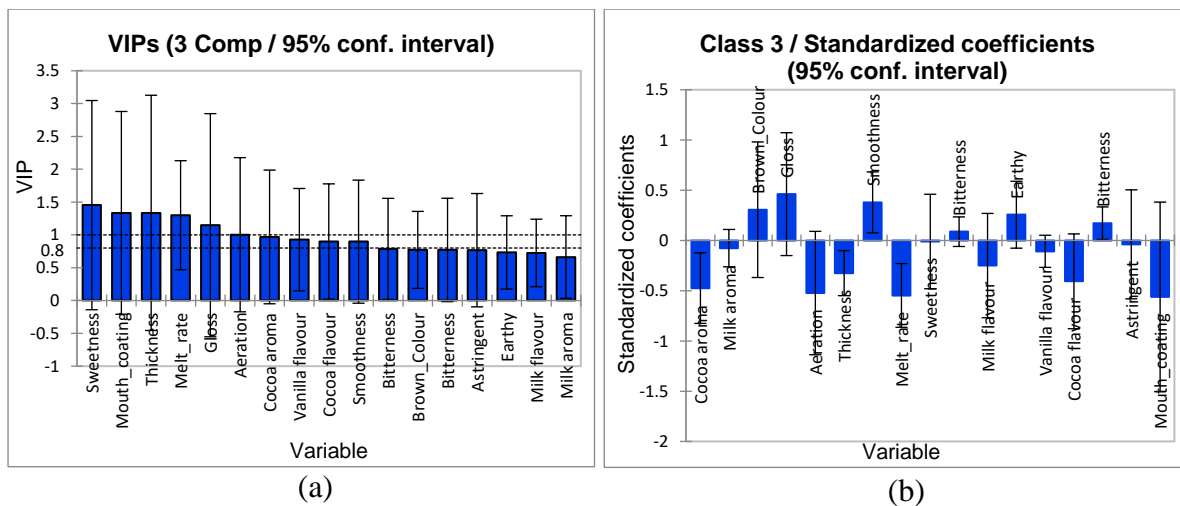


Figure 3.4.6 (a) Variable importance for the projection (VIP) and (b) regression coefficients of all attributes for cluster 3. Attributes with VIP greater than 0.8 are important drivers of liking/disliking

Information from preference mapping and the comment analysis are complementary and allow a better understanding of consumer preference. For example, the high frequencies of comments on chocolate flavour, sweetness and texture indicate their importance to consumer preference and supports similar findings from preference mapping. There was some disparity between the findings from preference mapping and comment analysis. This is similar to reports by Symoneaux et al. (2012). Although astringency and bitterness were indicated as significant drivers of preference for some consumer clusters by preference mapping, the low frequency of comments on both descriptors may indicate that they were not important for most consumers. The disparity in the importance of these sensory attributes may indicate higher sensitivity of the panel to detect differences in the intensities of these attributes in the product compared to consumers.

3.4.3.5 Sensory specification for quality control

Considering the drivers of liking for consumers that liked M2 (C1 and C2), the characteristics that drove liking of M2 were aeration, smoothness, moderate milk aroma and flavour, while the drivers of disliking were high colour intensity, melt rate, cocoa and bitterness. Findings from comment analysis support these observations and provide more information on the drivers of consumer preference for M2. A higher frequency of like comments for M2's aeration, smoothness and sweetness compared to dislike comments was observed, thus supporting the role of these sensory attributes as drivers of liking. The opposite trend was observed for comments relating to the appearance, non-chocolate flavour and aftertaste of M2, so these may

be drivers of disliking. A similar number of like and dislike comments were observed for chocolate flavour and texture. This may indicate that almost the same number of consumers liked/disliked these sensory attributes in M2. These attributes along with the descriptive sensory data from the trained panel were used to develop the sensory specification of M2 (Table 3.4.9).

Findings from preference mapping and comment analysis reveal some potential points of improvement of the sensory quality of M2. The aftertaste of the product may be improved as this was a driver of disliking. Further investigations into the intensity of the thickness and melt rate may also be carried out as M2 is characterised by high intensities of these attributes, which were identified as drivers of disliking for C3 consumers.

Table 3.4.9 Sensory specifications for the target chocolate mousse

Sensory attribute	Description	Target (IN)
Brown colour	The sensory characteristics perceived on visual inspection of a scooped spoonful of product under artificial daylight.	Light brown chocolate colour (picture showing the target colour intensity should be provided)
Aeration	Honeycomb structure. Evaluated by looking at the product surface after scooping a spoonful under artificial daylight	Even, honeycomb structure (Picture should be provided with the desired honeycomb structure)
Smoothness	Absence of lumps, particles and grits. Evaluated by eating a teaspoon full of product	No grits or lumps
Thickness	Resistance of the food to compression between the tongue and palate. Evaluated by eating a teaspoon full of product	Firm, spoonable, holds form briefly before melting in the mouth.
Milk flavour, chocolate flavour	The flavour perceived in the mouth when eating a teaspoon full of product.	Moderate milk chocolate flavour with no off flavour (references should be identified by the panel)
Sweetness	The sweet taste perceived in the mouth when eating a teaspoon full of product.	Low sweetness typical of unsweetened full cream milk
Bitterness	The bitter taste perceived in the mouth when eating a teaspoon full of product.	Low bitterness, typical of milk chocolate (references should be identified by the panel)

3.4.4 Conclusions

This study illustrated the development of a sensory specification for quality control of chocolate mousse based on the critical sensory attributes identified by preference mapping and comment analysis and their average intensity in the target product. The critical sensory

attributes identified by preference mapping varied from one consumer cluster to another. In summary, the drivers of liking of chocolate mousse by C1 and C2 was driven by higher intensities of smoothness, aeration, vanilla flavour, milk aroma and flavour. Furthermore, the drivers of disliking were low melt rate and high intensities of cocoa aroma and flavour, astringency, gloss and bitterness. For C2, the drivers of liking were higher intensities of smoothness, aeration, milk aroma and flavour (Figure 3.4.3b). Comment analysis revealed that chocolate flavour, non-chocolate flavour, sweetness and texture were important drivers of preference. Thus, supporting the findings from the PLS regression. The target product was characterised by light brown colour, even honeycomb structure, high smoothness and thickness, milk chocolate flavour and a low sweetness.

These findings enabled the development of the sensory quality specification for the target mousse. The development of a sensory quality specification based on critical sensory indicators could be used to ensure that the screening of products during sensory quality control is based on criteria that are relevant to the consumer. The methods described in this study can be applied to other products.

4 DISCUSSION

This chapter provides a critical discussion of the various steps taken to develop, pilot test and validate a questionnaire to assess sensory quality control knowledge, attitudes and practices in the food industry. The development of a sensory quality system based on the identification and monitoring of critical sensory indicators is critically reviewed. Subsequently, the results of the questionnaire development and validation are discussed. Then, the implementation of the sensory quality system in the chocolate mousse case study is reviewed.

4.1.1 Research design

Sensory quality control (SQC) systems in food companies are usually designed and implemented by employees (Kilcast, 2010), thus sound knowledge and competence are necessary for success in the process. The knowledge, attitude and practices (KAP) model have been widely used to understand and drive improvements in practices based on knowledge and attitude focused interventions (Zanin et al., 2017). The marginal or wrong application of sensory principles has been discussed in literature (Munoz, 2002, Costell, 2002, McGrew and Chambers, 2011), however, a tool for the evaluation of SQC related knowledge has not been documented. Therefore, this study focused on applying the KAP model to develop and validate a questionnaire for the assessment of food company employees' SQC related knowledge, attitudes and practices.

Another widely discouraged and marginal SQC practice is the reliance on finished product testing (Munoz, 2002, An and Wang, 2016, Stefanova and Zlateva, 2018) as defective products are often detected late in the production chain which may lead to waste (Stefanova and Zlateva, 2018). Some authors have suggested the monitoring of raw and in-process materials as well as the reliance on physical and chemical analyses for monitoring most stages and the utilization of a trained panel for monitoring of only the critical steps (Aumatell, 2011, Munoz, 2002). The second objective of this study was to describe the development of a sensory quality system based on defect assessment and targeted monitoring of critical steps in the production process. This system was illustrated using chocolate mousse production. This is one of the first studies that presents a system-wide approach to sensory quality management and the first to use a defect rating system based on drivers of consumer liking/ disliking.

4.1.2 Ethics approval

Ethics approval was obtained from the Ethics committee of the Faculty of Natural and Agricultural sciences, University of Pretoria prior to the commencement of the study (180000041- Appendix 6). Informed consent was obtained from all participants before they took part in the study. The consent form clearly stated the purpose of the study, that participation was voluntary and how the data collected would be used. Participants were also informed of their right to withdrawal from the study with no penalty and their rights to access their data. Participants in the sensory evaluation tests were duly informed of the ingredients and/or likely allergens in the samples. The consent forms used for the pilot and validation studies are presented in Appendices 6 and 7, respectively. The online questionnaire used on Qualtrics platform for the validation study is provided in Appendix 8.

4.2 QUESTIONNAIRE DEVELOPMENT AND VALIDATION

4.2.1 Questionnaire development

A structured, self-administered questionnaire was developed based on existing literature on sensory quality control (Kilcast, 2010, Stone and Sidel, 2004, Munoz, 2002, Lawless and Heymann, 2010). In line with the KAP model, the questionnaire had three sections- knowledge (15 questions), attitudes (seven questions), and practices (eight questions). A fourth section (respondent and company characteristics- 12 questions) was used to collect descriptive information for profiling respondents and their companies. The questionnaire was written in English, which may have impacted the responses as this is not the mother tongue of most respondents. In addition, respondents with low to medium literacy levels may struggle to understand some questions.

The knowledge questions had three possible responses ‘yes’/ ‘no’/ ‘I don’t know’. Correct responses were awarded one (1) point, incorrect and I don’t know responses were awarded zero (0) point (Zahiruddin et al., 2018). The ‘I don’t know’ option was included to reduce the incidence of guessing and to determine the respondent’s awareness of their lack of knowledge (Agüeria et al., 2018). The five-point Likert scale (1- strongly disagree to 5- for strongly agree) commonly used in the assessment of attitudes was adopted, five (5) points were awarded for most positive attitude and one (1) point for most negative attitude, i.e., 1- strongly disagree to 5- for strongly agree, the scoring was reversed for negatively-worded questions (Zahiruddin et al., 2018). The practice questions had three multiple-choice options ranging from marginal/

least good- awarded one (1) point to very good practice- awarded three (3) points, P6 had three (select all that apply) responses awarded one (1) point each and summed to get a total score.

A sum of scores for each section was computed for each respondent and their performance classified. A total score $\geq 50\%$ on the knowledge, attitudes or practices section was considered good and acceptable (Agüeria et al., 2018). While a total score $\geq 75\%$ was excellent.

4.2.1.1 Respondent recruitment and data collection

Respondents were sent the invitation to participate in the pilot phase via LinkedIn and email. While for the validation phase, the survey invite was shared with some food science groups on LinkedIn, Facebook, and WhatsApp. The invitation was also emailed to members of the national associations for food science professionals in Nigeria and South Africa (Nigerian Institute of Food Science and Technology- NIFST and South African Association for Food Science and Technology- SAAFoST) and through the webpage and newsletter of food focus (www.foodfocus.co.za). Individuals interested in sensory evaluation could have been more likely to complete the survey because of the invitation process, causing bias in the responses. Respondents completed the questionnaire online on the Qualtrics^{XM} (Qualtrics LLC, Provo, USA) platform (www.qualtrics.com). The administration of the questionnaire online may have led to the exclusion of food company employees with limited access to the internet. Thus, future studies should consider using paper questionnaires in addition to online administration.

4.2.1.2 Content validation and pilot testing of the questionnaire

Validity tests are carried out to determine the accuracy and relevance of the measurements collected by the questionnaire to its intended purpose (Knekta et al., 2019). There are three types of related validity evidence, content, construct, and criterion validity. Content validity provides information on the relevance of the questions to the subject of interest (construct) (Peeters et al., 2013). Content validity is commonly assessed by a group of experts who rate the relevance of the question to the construct (Rubio et al., 2003). It can also be assessed as face validity, which determines whether the language used reflect the subject of interest. it is usually evaluated by a sample of the intended users of the questionnaire. Construct validity relates to the extent to which the subject of interest is covered. Three types of evidence can be used to support construct validity – factorial validity, convergent/ discriminant validity, and known groups validity. Item reduction analysis. Criterion validity examines the relationship

between the score on the test and performance on a related measure (Boateng et al., 2018). This was not assessed in this study as a related existing measure was not found for comparison with the questionnaire. Item reduction analyses are a set of tests used to improve the validity and reliability of a test by ensuring that only the most functional and internally consistent questions that support a parsimonious model are included (Boateng et al., 2018).

Content validity

In this study, the content validity index (CVI) of each question was used to determine its relevance in the assessment of SQC related knowledge, attitudes, and practices. The CVI of a questionnaire is usually determined prior to the collection of data from the target population. The early determination of the content validity will provide information on the clarity and representativeness of the questions (Rubio et al., 2003). Typically, five to seven subject experts or members of the target population judge the content validity of the questions (Boateng et al., 2018). Hence, the relevance of the questions in the study was independently examined by six sensory evaluation experts using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). A question was relevant if five out of the six experts agreed (rated it 4 or 5) (Rubio et al., 2003, Dos Santos et al., 2019). Due consideration was taken to select experts with varied and extensive sensory evaluation knowledge and experience. Three of the experts were academics, and three were sensory scientists in the food industry. Three of the experts had over ten years of experience, and the other three had over five years of sensory evaluation experience. Content validity was not carried out after more questions were added to the questionnaire as new questions were added based on the common sensory evaluation themes of the previously validated questionnaire.

Factorial validity

Factorial validity (a form of construct validity) examines the structural relationship between the questions/ items to determine the nature and extent of correlation and if they measure one underlying topic or several sub-topics (Peeters et al., 2013). This is usually achieved by carrying out exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and item response theory analysis. As the name implies, EFA is exploratory in nature, the goal is to group the questions into unobserved variables (factors) based on the correlation patterns observed in the data. (Knekta et al., 2019). EFA is commonly used in the development of new measurement instruments to determine the dimensionality of the questions (Flora and Flake,

2017). The principal axis factoring (PAF) method was used as it has been shown to produce reliable estimates for non-normal data (such as the study data), and for high or low communalities (Watson, 2017). Multiple criteria such as eigenvalue, parallel analysis (PA), Velicer's minimum average partial (MAP) correlation test, the inflection point on the scree plot, etc. were used to select the factors that provide the simplest model and adequately represents the underlying pattern. Multiple criteria are recommended as there is no single best method for determining the number of factors (Schmitt and Sass, 2011). The PA and Velicer's MAP tests are usually recommended by researchers as eigenvalue and scree test are heuristic (Knehta et al., 2019). The retention of factors based on the eigenvalue criterion usually leads to over-extraction, and the scree test sometimes reveals multiple inflection points (Watson, 2017). CFA is carried out to confirm a factor structure that was postulated either by sound theoretical knowledge or an EFA. The major difference between EFA and CFA is that for the former the relationship between the observed variable and the factor(s) is freely estimated, while for the latter, it is restricted (Flora and Flake, 2017). In the pilot study, the suitability of the data for factor analysis was determined by Kaiser-Meyer Olkin's measure of sampling adequacy (KMO MSA) and a Bartlett's test of sphericity, the threshold for acceptance was values greater than 0.6 and less than 0.05, respectively (Watson, 2017). These indicate that the questions are correlated and that the sample is adequate. The internal consistency of the retained factors was determined as the Cronbach's α .

Known groups validity

Construct validity was assessed by comparing the performance of different groups of respondents who are expected to have different levels of knowledge or practices (for companies) (Stanifer et al., 2015). Respondents were classified based on the information they provided in the respondent/ company characteristics section. Some demographic information such as education level which may have impacted the understanding of the questions and knowledge level of respondents was not collected. Furthermore, the responses were compared using one characteristic (factor) per time, a multivariate analysis may better capture the effect of causal factors on knowledge, attitudes and practices as it will capture the relationship between multiple factors and the observed data better representing real-life context.

Item analysis

This is usually accomplished through the classical test theory (CTT) or item response theory (IRT). Both theories estimate similar item parameters- difficulty and discrimination; however, while the estimates generated by CTT are sample specific, IRT estimates are sample independent (Mead and Meade, 2010). Additionally, IRT estimates item and model fit. In literature, the IRT model is selected based on the item response format, the assumption that and items' discrimination power is constant etc. (Nguyen et al., 2014). In this study the best model is selected from the three possible IRT models for dichotomous data- the three parameter logistic (3PL) model that relates responses to the respondent's ability three item parameters- difficulty, discrimination and guessing; the 2PL model assumes there is no guessing and the 1PL model sets a single discrimination parameter across all items (Ward et al., 2016). The 1PL model is usually favoured due to its parsimony and smaller sample size requirements, however, the assumption of a constant discrimination power for all questions usually does not hold in the real world (Nguyen et al., 2014), thus it was not considered in this study.

CTT difficulty and discrimination indices were determined for the knowledge questions in the pilot study. The difficulty index was estimated as the proportion of respondents who selected the correct answer to the total respondents, values from 0.1 to 0.9 were considered acceptable (Whati et al., 2005). The higher the difficulty index, the easier the question. This allows the selection of questions of the right (*average*) level of difficulty (Pande et al., 2000). The discrimination index was determined by ranking respondents based on their total score and finding the average of the difference between the number of respondents who select the correct answer in the upper quartile from those in the lower quartile. Values ≥ 0.2 were considered acceptable (Chen et al., 2013).

Reliability

Reliability is a measure of the reproducibility of the test that is considered an evidence of validity by some researchers (Peeters et al., 2013). There are several types of reliability evidence that could be considered: internal consistency, inter-rater reliability, composite reliability, etc. A commonly used measure of reliability is internal consistency which estimates whether questions of the same factor generate similar responses on a specific administration of the test. The Cronbach's α is a test of internal reliability (Singh, 2017). The inter-rater and intra-rater reliability assesses consistency across judges and across multiple ratings from the

safe judge, respectively. Both forms of reliability are usually determined as the intraclass correlation coefficient (ICC) (Koo and Li, 2016). Internal consistency of the retained factors in the pilot study was assessed as Cronbach's α . Cronbach's α has been argued to underestimate the internal consistency of ordinal variables due to the underestimation of the correlation between these variables, however this is a misconception as Cronbach's α is computed based on the covariance of the data and makes no assumptions about the nature of the distribution (Chalmers, 2018). Moreover, the popular alternative, ordinal alpha, is not suitable as it leads to an overestimation (more so for dichotomous data) as it estimates the unobserved relationship between the variables using polychoric correlations. Thus, Cronbach's α was used in this study.

4.2.1.3 Questionnaire refinement and validation

The questionnaire was refined based on the limitations revealed in the pilot study and recommendations for improvement of the questionnaire from reviewers of the journal paper published on the pilot test. The revision included the addition of new questions (K- 15, A- 10, P- 1 questions), rephrasing of existing questions (K- 7, A- 1, P- 5 questions), modification of the response options (P- 5 questions) and deletion of some questions (K- 2 and A- 4 questions). The revised questionnaire comprised 24 knowledge, 13 attitudes and, nine practice questions. As in the pilot study, a respondent and company characteristics section was included to collect information for profiling the respondents and their company. The data collected in the refinement study was split into two, 35% for IRT analysis and EFA, and 65% for CFA. This is because the use of the same sample for EFA and CFA is largely condemned by researchers as the results from the latter may not be generalisable and may be due to sample-specific relationships (Flora and Flake, 2017, Knekta et al., 2019).

In the questionnaire refinement study, IRT analysis was carried out on the knowledge questions to select questions of optimal difficulty and discrimination power. The data was fitted to the 1 PL, 2 PL and 3 PL models (Ward et al., 2016). The model fit indices were compared to select the best model. The parameter estimates generated by the selected model was used for question selection.

EFA was carried out on the polychoric correlation matrices of the attitude and practices sections by the unweighted least squares method using IBM SPSS 26 (Aletras et al., 2010). EFA was used to examine the underlying structure of the refine questionnaire. The number of

factors retained was determined by the logical interpretation of the proposed by parallel analysis and the scree plot. The internal consistency of the retained factors was determined as the Cronbach's α .

CFA of the polychoric matrices was performed in R Version 4.0.5 with Lavaan package using the diagonally weighted least square (WLS) estimation method (Zahiruddin et al., 2018) to confirm the factor model proposed by the EFA. The polychoric matrices were used instead of Pearson's correlation matrices for factor analysis in the questionnaire refinement study as the data is ordinal in nature. Furthermore, the use of Pearson's correlation matrix has been shown to result in the underestimation of the correlation between the variables and thus decrease the factor loadings based (Holgado-Tello et al., 2009). The goodness of fit of the CFA model was determined by multiple indices- comparative fit index (CFI), Tucker-Lewis fit index (TLI), root mean square error of approximation (RMSEA) and standardized root-mean-square residual (SRMR). The threshold for acceptance for the model were values > 0.9 , > 0.9 , < 0.8 , < 0.8 (Ward et al., 2016, La Barbera et al., 2020), respectively.

4.2.2 Research findings- Validation and pilot testing of the questionnaire

The steps taken to validate the questionnaire are summarized in Figure 4.1.

4.2.2.1 Content validation

The initial questionnaire consisted of four sections- respondent and company characteristics (12 questions), knowledge (15 questions), attitudes (eight questions) and practices (eight questions). Content validation of the initial questionnaire by six sensory evaluation experts revealed that most of the questions were relevant to the assessment of SQC KAP. Three questions were considered irrelevant: C3 (*Is your company a part of another larger company*), C4 (*What is the total number of employees at your location*) and K13 (*Are consumer preference tests suitable for sensory quality control*). C3 and C4 were retained as they provided information that is vital to characterize the company of the respondent. The affiliation of a company to a larger company may provide better access to sensory quality expertise and systems that will in turn impact on their sensory quality practices. The number of employees in the company was used to determine the size of the company as defined in World Trade Organisation (WTO) report 2016. K13 was initially retained as it relates to the knowledge of

good sensory practices. However, it was removed later as it did not discriminate well between respondents of different knowledge levels.

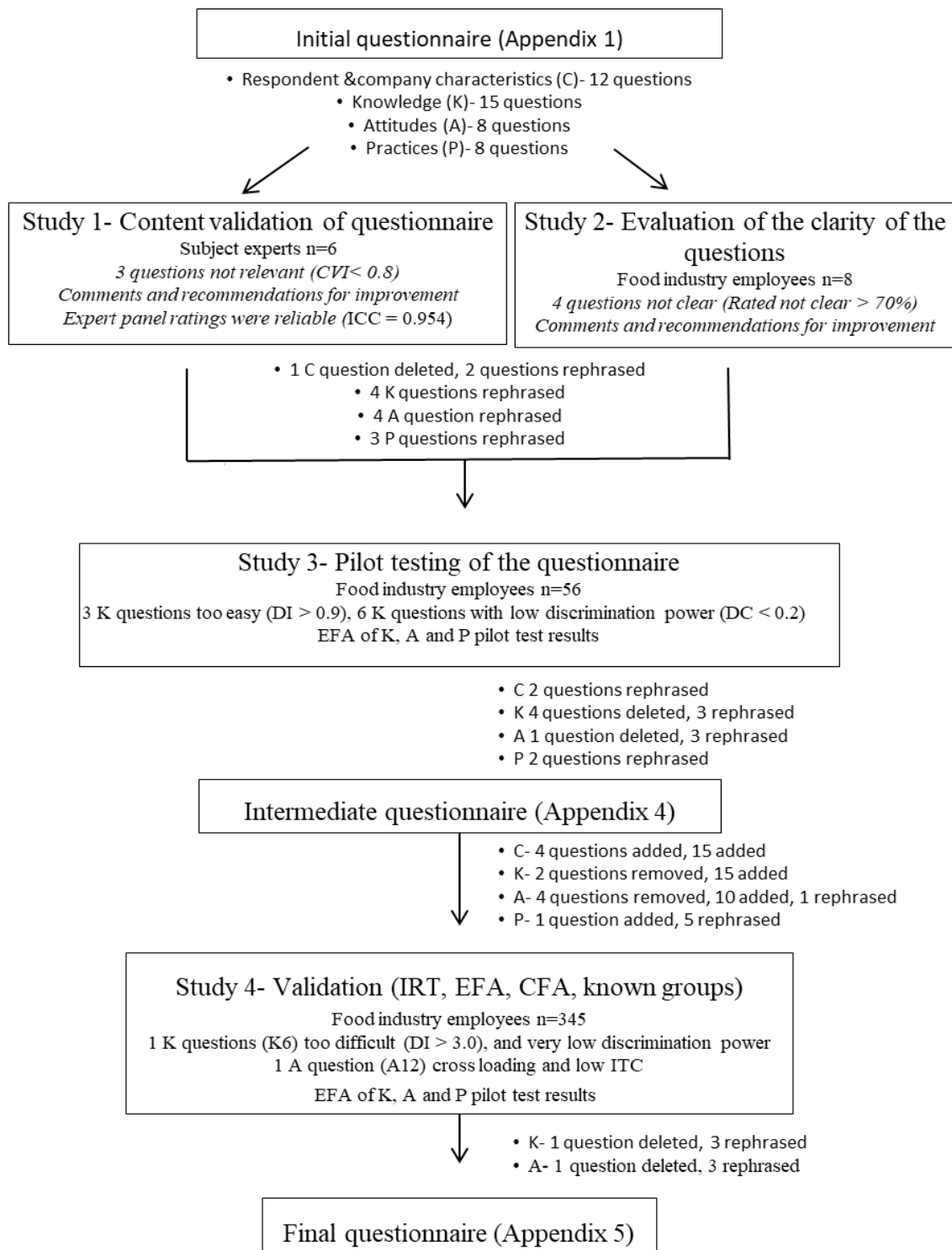


Figure 4.1 Steps of questionnaire validation. CVI- Content validation index, ICC- Intra-class correlation coefficient, DI- difficulty index, DC- discrimination index, IRT- item response theory, EFA- exploratory factor analysis, CFA- confirmatory factor analysis, ITC- item to total correlation

4.2.2.2 Questionnaire clarity

The clarity test carried out by eight food industry professionals revealed that the language of the questions (except for K2, K3, K5, K10 and K11) were clear. Comments from respondents regarding K2 (*Is umami one of the basic tastes?*), K5 (*Is palate cleansing a good sensory practice?*) and K11 (*Is a t-test used for analysing sensory results of more than two products by the same group of people?*) revealed that they were not familiar with the technical terms used and this may have affected the clarity of the questions. The questions (except for K2) were rephrased due to recommendations from the sensory experts and/or the food industry professionals. This is similar to previous studies where questions were rephrased based on the recommendation of experts and intended users (Dickson-Spillmann et al., 2011, Jones et al., 2015).

4.2.2.3 Pilot study and initial validation

A pilot study of the questionnaire was carried out. The purpose of the pilot study was to assess the feasibility and efficiency of the participant recruitment process, survey administration, data coding and analysis strategies (Rubio, 2003). The pilot study revealed that the knowledge section was not suitable for factor analysis due to its dichotomous nature as well as unacceptable KMO MSA and Bartlett's test of sphericity results. This led to the use of IRT analysis and EFA on polychoric correlation in subsequent questionnaire refinement steps.

4.2.2.4 Refinement and validation of the questionnaire

Refinement and validation of the questionnaire was carried out by adding new questions based on the limitations revealed in the pilot test and initial validation stage. IRT analysis revealed that the 2PL model had the best fit for the data, this indicates that responses to the knowledge questions were determined by the difficulty and discrimination of the questions as well as the respondent's knowledge level. K6 was removed as it had difficulty and discrimination parameters that were not acceptable. Modified parallel analysis revealed that the knowledge section is unidimensional, while the test information showed that the question adequately covered different levels of ability. Exploratory factor analysis after the removal of one question (A12) led to the retention of a two-factor solution. The two factors related to positive and negative disposition towards SQC. Questions (except P6) in the practices section formed one-factor. P6 was not included as all respondents selected the same option, however it was retained

in the questionnaire to preserve the content validity (Román and Sánchez-Siles, 2018). Cronbach' alpha was 0.703 and 0.683 for the knowledge and practices sections, respectively.

The one-factor model for the knowledge section showed a good fit, CFI = 0.946, TFI = 0.940, RMSEA = 0.020 and SRMR = 0.106. The one-factor model for the practices section also had good fit, CFI= 0.978, TFI= 0.968, RMSEA= 0.066 and SRMR = 0.068. However, the two-factor model for the attitude section did not fit well, CFI = 0.825, TL1 = 0.777, RMSEA = 0.112 and SRMR = 0.104.

Known groups comparison revealed that respondents with sensory evaluation training had a significantly higher total knowledge score than those without. Furthermore, the total knowledge scores of participants with sensory related work experience were significantly higher than those without. This indicates that training and experience lead to knowledge gains. The total practices score however did not differ for companies of different sizes nor for companies for which the respondents reported a higher frequency of customer complaints. Examination of the data revealed that the nature of the products and affiliation with a larger company may have positively impacted on a company's SQC practices. The results may also indicate that the frequency of complaints may not be a true reflection of good product sensory quality practices.

4.2.2.5 Guidelines for administration of the questionnaire

Practitioners should follow these guidelines when administering the questionnaire.

- i. Decide and specify the reason/s for using the questionnaire e.g., research, determining the KAP of company employees.
- ii. Determine which demographic and identifying information should be collected from respondents. These questions will form the employee characteristics section. Consider the regulations stipulated by the general requirements of the protection of personal data legislation.
- iii. Choose a format for the administration of the questionnaire based on the needs and resources of the company (Online surveys are easier to collate, interview style may be more relevant for low literate employees, while paper surveys may be considered for administration of the survey during face-to-face training sessions).
- iv. Completion of questionnaire by the relevant employees.

- v. Collation of data and calculation of the total scores of each respondent on the different sections of the questionnaire

Responses to the knowledge section should be awarded zero (0) points for an incorrect/ I don't know answer and one (1) point for a correct answer. Responses to the attitude section should be awarded one (1) point for the most negative answer and five (5) points for the most positive answer using the five-point scale. Responses to the practice section should be awarded (1) point for the worst practice among the three options and three (3) points for the best practice.

- vi. The performance of respondents for each section can be classified based on their total score: poor for $< 50\%$, good for $50- 74\%$ and excellent for $\geq 75\%$.
- vii. Individual and group performances can be reviewed to identify areas of poor performance, such as the most difficult knowledge questions or the practice questions scoring < 3 .
- viii. Appropriate interventions can be introduced to address any gaps revealed by the findings from the questionnaire.

Where possible the sequence of the questions per section should be randomised so that all employees will not answer the questions in the same order. This randomisation is usually supported by online survey collection tools such as Qualtrics. Some questions related to SQC of a specific product may be added to the relevant sections of the questionnaire. The questionnaire should be validated where it is modified. The assessment of the SQC practices of a food company by an independent (third-party) organisation may be carried out by observation (in the form of a factory audit) rather than the completion of the questionnaire by company employees. This will reduce misreporting as self-reported practices may differ from observed practices (da Cunha et al., 2019). Furthermore, future studies may also seek to compare observed practices with reported practices using the questionnaire to understand the difference between them as well as the effect of literacy level and reporting bias.

4.3 DEVELOPMENT AND ILLUSTRATION OF THE SENSORY ANALYSIS CRITICAL CONTROL POINTS SYSTEM

4.3.1 Development of the sensory quality system

The development of a preventive system-wide approach to sensory quality control, the sensory analysis critical control point (SACCP) was described. The system was developed over two phases using a case study of the production of chocolate mousse. First, the sensory indicators that drive consumer preferences were identified through preference mapping. Then the

manufacturing process was examined to identify the likely sensory defects occurring at each step and the definition of the control and monitoring actions that can be applied to ensure that the sensory indicators are kept within acceptable limits. The steps taken in the development of the sensory system are summarized in Table 4.1.

Table 4.1 Description of the steps for development of the sensory analysis critical control point (SACCP) quality system

No.	Steps in SACCP Development	Description
Preliminary steps		
i	Assemble the sensory quality team	A multi-disciplinary team responsible for the development, validation and maintenance of the sensory quality system is assembled
ii	Draw production flow diagram	The manufacturing steps are identified and described. Onsite verification of the production flow is carried out
iii	Definition of target sensory quality	The sensory quality indicators that are critical to consumer preference are identified and used to develop the sensory quality specification
Main steps		
1	Sensory quality defect analysis	This is carried out to identify the significant sensory quality defects that is/ are likely to occur that needs to be controlled or else the final product will not be acceptable to the customer/consumer
2	Determine the critical control points (CCPs)	Critical points at which control can be applied to prevent/ eliminate or reduce a sensory defect to tolerable levels are identified
3	Establish critical limits	This determines the maximum and/or minimum values within which the control measure must be kept at the CCP
4	Establish monitoring procedure	This determines the observations and measurements that can be used to establish whether the CCP is under control
5	Establish corrective action	These are actions or steps that can be taken to prevent undesirable products from reaching the customer/ consumer once a deviation from the CCP is detected
6	Establish verification procedures	These procedures determine the validity/ effectiveness of the SACCP plan and system operation
7	Establish record keeping and documentation procedures	These are record and documentation procedures for the SACCP plan

4.3.1.1 Preference mapping

Preference mapping is a group of techniques commonly used in product development studies to identify the relationship between hedonic data and the characteristics of the product to understand consumer preference (Cariou et al., 2014). Preference mapping has been used to

compare descriptive data to consumer data to validate a scoring system for SQC of date fruit (Ismail et al., 2001). Partial least squares regression (PLS) is a method that simultaneously uses consumer preference data and instrumental or descriptive sensory data to develop a perceptual map of the products. This allows the map to be based on components that explain both the consumer liking and product characteristics, thus, ensuring that the perceptual space is relevant to consumer liking (Liggett, 2010).

Quantitative descriptive analysis (QDA) by a trained panel is usually the method of choice for objective and comprehensive identification of the nature of difference between two or more food products. The QDA of six commercial chocolate mousses (M1- M6) was conducted by a trained panel of eight members (six females and two males). Two samples of the case study products were included for profiling, and four competing products were included for preference mapping purposes. For the case study, the competing products were also considered as variations in the product due to the company's manufacturing process. One of the case study product (M2) was purchased from retail stores and the other was collected from factory retention samples (M1). The four competing products were purchased from retail stores, they were selected based on availability and to capture variation in the product range.

The validity of the QDA data collected depends on the performance of the trained panel, hence considerable effort is usually applied to the selection and training of the panel. The panellists in this study had been screened for their sensory acuity and ability to describe the sensory properties of products. The panel was trained for nine hours over three days to familiarize them with the products and the evaluation protocol. Then the panellists individually generated sensory descriptors that best differentiated between the chocolate mousses. The final list of sensory descriptors ($k=21$) for the characterisation of the chocolate mousse was selected by consensus among panellists. Panellists evaluated the six chocolate mousses over three replicate sessions using a nine-point unstructured intensity line scale (Torri et al., 2015). Most sensory studies have reported the use of three evaluations (Djekic, Lorenzo, Munekata, Gagaoua, & Tomasevic, 2021). Furthermore, a third evaluation did not improve the statistical analysis of the results compared to two evaluations, and one evaluation provides good information on the data (Peltier, Mammasse, Visalli, Cordelle, & Schlich, 2018). Principal component analysis (PCA) was carried out to develop the sensory map of the chocolate mousses.

Preference test was carried out on five of the chocolate mousses (all purchased from retail stores) by 79 regular consumers of chocolate mousse. Consumers rated their preference for the chocolate mousses using a nine-point hedonic scale (1= dislike extremely- 9= like extremely) (Masson et al., 2016). The number of consumers used is similar to that in previous studies (Bernstein, 2015, Janiaski et al., 2016), and also within the minimum sample size (40 – 100) commonly recommended (Gacula Jr and Rutenbeck, 2006). Consumers also made free comments about liking/ disliking the products.

All Sample evaluations was carried out in individual booths, at room temperature (25 ± 2 °C), and under artificial white day light. The samples were served at 4 ± 2 °C, the order of sample presentation was randomized using the Williams Latin square design.

Prior to applying preference mapping, the consumers were clustered into groups based on their overall liking rating of the chocolate mousses using hierarchical cluster analysis. There are multiple recommendations for performing cluster analysis, a cluster can contain at least 20% of the total number of consumers (Liggett, 2010; Meullenet, Lovely, Threlfall, Morris, & Striegler, 2008) or at least 50 consumers (MacFie, 2007). The former recommendation was followed in this study. Preference mapping was carried out by the PLS regression of the average intensity of the sensory attributes from the trained panel and the average liking scores of the products from the consumer groups (Liggett, 2010). All analysis were carried out using XLSTAT 2020 (Addinsoft, Paris, France). The fit of the PLS model was assessed using R^2 and Q^2 cumulative (Q^2 cum) (Tenenhaus et al., 2005), the model was automatically selected by XLSTAT using the default Jackknife Leave-one-out (LOO) method. The PLS regression for each group of consumers was analysed and the variable importance of projection (VIP) output used to identify the critical sensory quality indicators that drive consumer liking, sensory attributes with VIP greater than 1 were considered critical (Cariou et al., 2014).

Consumer comments were prepared for analysis by identifying the sensory attributes described and their valence (liking/ disliking). Similar comments were grouped together and the frequency of the sensory attributes for each product collated (Symoneaux et al., 2012). Chi square test of independence was used to identify significant differences between the frequency counts for each product (Mahieu et al., 2020). The critical sensory attributes were defined as those with the highest frequency (top three) that also differed significantly between the

products as it is logical for consumers to comment on the sensory attributes that are important to them.

The sensory specification of the target chocolate mousse product was described using the critical sensory quality indicators and the mean intensity for the sensory attributes for the product obtained from the trained panel. In this study, preference mapping served multiple purposes. It enabled the comparison of the sensory properties of the product with that of competitors, the identification of drivers of consumer liking/ disliking for the product, and the identification of potential areas of product improvement.

4.3.1.2 Determination and control of the critical control points

Some preliminary steps were carried out before the determination of the critical points in the manufacturing system that must be controlled to ensure that the sensory quality of the final product is acceptable to consumers. A multidisciplinary team was created, this comprised of the production manager, quality manager, product development specialist and the PhD student. The team was responsible for developing the sensory quality system.

The SACCP team developed a production flow diagram for the chocolate mousse. Production of the chocolate mousse was accomplished through nine steps: receipt of raw materials, storage of raw materials, weighing of raw materials according to the formulation, cooking and mixing of raw materials, cooling of in-process slurry, cooling and aeration, weighing and packaging, cold storage and dispatch into cold truck. Factory observation was carried out to verify the flow diagram.

Sensory defect analysis was carried out using a semi-quantitative method. The SACCP team identified and prioritised the sensory defects that could arise at each step of the production based on the semi-quantitative risk assessment method. Each sensory defect was classified as critical based on their likelihood of occurrence and severity of the dissatisfaction experienced by the consumer because of the sensory defect. Customer complaints data may also provide useful information to classify the likelihood and severity of the sensory defects. However, there was very low incidence of customer complaints (only 1 in over two years) at the case study factory, this related to the stability of the foam structure. Literature may also provide some guidance in the classification of the likelihood and severity of the sensory defects. For instance,

texture has been identified as an important driver of preference of chocolate mousse (Duquenne et al., 2016). The sensory defect(s) was categorised as critical if the severity of occurrence was moderate to high, and the likelihood of occurrence was high or if the severity of occurrence was high and the likelihood of occurrence was medium. Steps with critical sensory defects are considered critical control points (CCPs).

The means for control of each sensory defect was determined by the SACCP team based on experience and literature review. Monitoring procedures for all CCPs were identified and documented. The important steps that are the last step where control of the sensory defect could be effected were designated as CCPs, these were identified using a CCP decision tree.

4.3.2 Research findings- sensory quality system

4.3.2.1 Description of the sensory profile of the chocolate mousses

The chocolate mousses were well differentiated by the trained panel as indicated by significant differences between the intensities of 17 sensory attributes, these were retained for further analysis. The products did not differ on hold, sourness, chocolate aroma and flavour. Panellists commented that the products had distinct cocoa and milk flavours rather than a flavour characteristic of milk chocolate or dark chocolate and this was supported by the non-significant differences between the chocolate aroma and flavour. The descriptors used in this study are similar to those in previous studies on chocolate flavoured dairy products (Thompson et al., 2004). Sensory profiling enabled the objective description of the sensory characteristics of the case study product and allowed for comparison to competitor products. The case study product was characterised by low levels of gloss, vanilla and earthy flavour, medium levels of sweetness, bitterness, cocoa and milk flavour and high levels of brown colour, aeration, smoothness and thickness. Unique points of differentiation of the case study product from the other products were its lower level of sweetness and higher levels of thickness.

Principal component analysis was able to capture the differences in sensory characteristics between the chocolate mousses, as two principal components (PCs) described 98.6% of the variance amongst the products. PC1 was characterised by cocoa and milk flavour, samples on the left had higher intensities of cocoa flavour and darker colour and samples on the right had higher intensities of milk flavour and aeration. Chocolate mousses with higher intensities of sweetness were positively correlated with PC2, while those with higher thickness and melt rate

were negatively correlated. Overall, the products formed three distinct clusters on the sensory map, with the case study product well differentiated from competing products thus suggesting its uniqueness amongst the products assessed.

4.3.2.2 Identification of critical sensory indicators

The critical sensory indicators were successfully identified using PLS regression and comment analysis. The critical sensory indicators were defined as the sensory attributes that drove consumer preferences. The products were generally liked by consumers with mean overall liking ranging from 4.64 to 7.33 (1- dislike extremely to 9- like extremely). Overall liking of the products differed significantly, pairwise comparison separated the products into three groups based on liking- most liked, moderately liked and least liked. The case study product was moderately to least liked. The overall liking of the chocolate mousses is similar to that reported previous studies on other dairy products, where products are generally liked with all products rated above 4 on a 9pt hedonic scale (Thompson et al., 2004, Janiaski et al., 2016, Gaze et al., 2015b).

Hierarchical cluster analysis of consumers based on their overall liking of the chocolate mousses revealed three groups, class 1 (C1), class 2 (C2) and class 3 (C3) made up of 32, 22 and 24 respondents, respectively. Preference mapping revealed that consumers in C1 and C2 preferred chocolate mousses with high smoothness, intense milk aroma and vanilla flavour, C2 additionally preferred a chocolate mousse product with high aeration and intense milk flavour, while C1 preferred products with high sweetness. Preference mapping and subsequent inspection of the variable importance of projection for each group of consumers revealed that C1 and C2 disliked products with intense cocoa flavour, astringency and bitterness, C1 also disliked slow melting products with high astringency while cluster 2 disliked higher intensities of brown colour and gloss.

Thus, the critical sensory attributes for consumer liking were identified as smoothness, milk aroma and flavour, aeration and vanilla flavour. While those for disliking were low melt rate and higher intensities of cocoa flavour, bitterness and thickness. Some of the critical sensory indicators identified in this study are similar to those reported for other dairy products in previous studies. Flavour, viscosity, brightness and smoothness influenced consumer liking of

strawberry flavoured yoghurt (Janiaski et al., 2016). Thickness, smoothness, viscosity and colour were drivers of consumer liking of French yoghurts (Masson et al., 2016).

The critical sensory quality indicators identified based on consumers comments were chocolate flavour, non-chocolate flavour, sweetness and texture. These were similar to the critical sensory quality indicators identified by preference mapping, thus supporting the results. Consumer sensory tests are usually expensive and time intensive, thus consumer preference information has previously been collected using a questionnaire (Ismail et al., 2001). A limitation of the use of questionnaire is that consumers would have to rely on their memory to identify what they liked /disliked about the product(s). Furthermore, variations in the eating context from one consumer to another may also introduce some bias. Consumer studies are usually expensive (Liggett, 2010), thus, to save costs, focus groups made up of the target consumers may be used to generate consumer preference data. The data may be subsequently regressed with descriptive sensory data from a trained panel.

The sensory specification of the product was developed by describing the average intensities of the critical sensory indicators in the case study product. The target product was described as light brown in colour, smooth, firm and spoonable with an even honeycomb structure. The product should have a moderate milk chocolate flavour, low sweetness and bitterness. The procedure for the evaluation of each sensory attribute was also described. The sensory specification may have been impacted by the limited consideration of the expected variation in the product from one batch, this was accounted for by taking products once over three weeks of production, a more robust sampling is desirable.

4.3.2.2 Identification and management of the critical control points

Two CCPs were identified, CCP 1 was related to the weighing of ingredients, while CCP 2 was related to the cooling and aeration of the in-process slurry to form a foam. Instrumental measurements were selected for monitoring of the CCPs as they could provide adequate control. Automated control, for instance in the weighing of the ingredients, will be more effective, however labour factors and cost of setup may discourage the adoption of such measures. The monitoring activity and critical limits identified should ideally be validated against sensory quality data, this was not carried out in this study. Details of the monitoring

procedure such as the personnel responsible and the frequency of monitoring were identified and documented. Corrective actions to be taken if a deviation is identified is also documented.

5 CONCLUSIONS AND RECOMMENDATIONS

The first purpose of this study was to develop and validate a questionnaire for the rapid assessment of SQC related knowledge, attitudes and practices. This is the first questionnaire that assesses the KAP multi-construct with regards to SQC. The questionnaire was validated using multiple methods to ensure the relevance of the data that will be collected with it. The validation tests enabled the identification and removal of non-discriminating questions and those that were not related to the constructs. Confirmatory factor analysis provided evidence of model fit for each section of the questionnaire. Overall, the study demonstrates that the knowledge and practices sections of the final questionnaire are valid and reliable. The attitude section needs further refinement and validation as the model fit was not acceptable. Despite this, the attitude section can be used, but the results should be interpreted with caution. The study also provides evidence of the over-reliance on finished product testing in SQC. Thus, highlighting the need for alternative approaches to SQC.

This study revealed that questionnaire development and validation is an ongoing process. For instance, the questionnaire may be modified to provide a more extensive assessment of SQC knowledge, attitudes and practices. This may be done by adding questions about the SQC of a specific product and/or administering the questionnaire as an interview. Furthermore, the assessment of SQC practices by independent or third-party stakeholders using the relevant section of the questionnaire may also take the form of a factory audit (observation and document review) rather than self-reporting of SQC practices by the company employees. Future studies can also seek to compare reported practices with observed practices.

The second purpose of this study was the illustration of a system-wide approach to sensory quality management. The study is one of a very few that presents a system approach, and it is the first to illustrate how to use preference data to identify critical sensory quality indicators and prevent the occurrence of sensory defects during the manufacturing process. Monitoring procedures for each CCP were identified and documented. This clearly specifies what is monitored, how it is monitored, when, the personnel that monitors it, and the corrective action where a deviation is observed.

The sensory quality system proposed in this study was not validated, hence, future studies to validate the sensory quality system, for example, with results from regular monitoring of the

finished product by a trained panel or by the ratings from consumers, are needed. One limitation of this study was the limited consumer profiling prior to the preference test, thus the critical sensory indicators identified in this study relate to regular consumers of chocolate mousse and not specifically the target consumers for the brand of interest. It is therefore recommended that future studies use the target consumers (based on the company's internal profiling) to identify the critical sensory quality indicators of the product.

In conclusion, the final questionnaire (Appendix 3) can be used by food companies and third-party stakeholders for the rapid assessment of food company employees' knowledge, attitudes and practices related to SQC. This will be useful to identify training gaps, screening of prospective panellists, and to identify practices that need to be improved to ensure the success of SQC programmes. The practices section may also be used by third party stakeholders to assess the commitment of food companies to sensory quality management.

The illustration of the development of the sensory quality system is a vital example for food companies seeking to develop such a system. The system has several advantages: it considers the preference of consumers in defining the sensory specification for quality control purposes, thus SQC monitoring will be consumer focused. The system also considers the origins of sensory defect in the manufacturing process therefore allowing for adequate control and monitoring. Data collected from monitoring of the critical steps may provide information for trouble shooting processing issues and for process improvement. Furthermore, implementation of the system should reduce the need for finished product monitoring as this becomes a validation step rather than a monitoring step. This research will serve as a base for future studies into the optimisation of sensory quality systems.

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7 PUBLICATION, PRESENTATIONS AND POSTERS

Publication

Onojakpor, O. and de Kock, H.L., 2020. Development and pilot testing of a questionnaire to assess sensory quality control (SQC) knowledge, attitudes and practices (KAP) of food company employees. *Food Quality and Preference*, 86, p.103996).

Conference poster

Ogheneyoma S. Onojakpor and H. L. de Kock. Development and validation of the Sensory quality control (SQC). 13th Pangborn Sensory Science Symposium, Edinburgh, Scotland. 28th July – 1st August 2019.

Early career researcher (ECR) video presentation

Conference oral presentation

Development and validation of a questionnaire to assess sensory quality control practices in food companies in African countries. 23rd Biennial International SAAFoST Congress and Exhibition, Johannesburg, South Africa. 1st - 4th September 2019

APPENDICES

APPENDIX 1: Initial questionnaire showing four sections: respondents' and company characteristics, knowledge, attitudes and practices

Identifier	Question Respondents and company characteristics section (Response options)
C1	Please choose which option best describes your main current job function? <i>1. Sales/ Marketing 2. Production/ Manufacturing 3. Quality Assurance 4. Research & Development 5. Others</i>
C2	Please choose which option best describes your current job level? <i>1. Entry Level 2. Intermediate 3. Middle Management 4. Senior Management 5. Owner/Executive</i>
C3	Is your company a part of another larger company? <i>1. Yes 2. No</i>
C4	What is the total number of employees at your location? <i>1. Less than 10 2. 10 to 50 3. 51 to 200 4. More than 200</i>
C5	In which country is your company located? <i>List of countries provided</i>
C6	Estimate the annual projected/ real gross income of your company? (Currency and response options depend on the country selected) <i>1. Less than 1,000,000 2. 1,000,001 – 10,000,000 3. 10,000,001 - 100,000,000 4. Above 100,000,000</i>
C7	How many products does your company produce? (Includes different formulations and excludes different pack sizes) <i>1. Less than 3 2. 3 to 5 3. 6 to 10 4. More than 10</i>
C8	Please select the food processing sector your company belongs to? (if more than one sector, please choose the most important) <i>1. Baked goods/confectionery 2. Beverages 3. Cereals and grains 4. Dairy 5. Frozen and/or chilled 6. Fruits and vegetables 7. Meat and/or fish and/or sea food 8. Oils and fats 9. Sauces and condiments 10. Others</i>
C9	Do you have a quality department? <i>1. Yes 2. No</i>
C10	Have you heard of sensory evaluation before this study? <i>1. Yes 2. No</i>
C11	Was there any customer complaint or reprocessing of a product due to unacceptable sensory quality in the last 12 months? <i>1. Yes 2. No</i>
C12	Which of the following sensory-related functions are you involved in? <i>1. None 2. Request sensory experiments 3. Plan sensory experiments 4. Run sensory experiments 5. Analyse sensory data and write reports 6. Make decisions based on sensory data</i>
Knowledge Section (Options: Yes, No, 'I don't know')	
K1	Can you smell food while it is in your mouth?
K2	Is umami one of the basic tastes?
K3	Can product feel be judged with the eyes?
K4	Should you judge product flavour if you have a cold/flu?
K5	Is palate cleansing a good sensory practice?
K6	Should food tasters know the allergens in the food they will be tasting?
K7	Is the order of presenting samples important during sensory tests?

K8	Is a triangle test a sensory discrimination method?
K9	Should preference questions be asked during descriptive sensory tests?
K10	Is a one-tailed alternative hypothesis suitable for analysing the results of a triangle test?
K11	Is a t-test used for analysing sensory results of more than two products by the same group of people?
K12	Should untrained people be used for sensory quality control tests?
K13	Are consumer preference tests suitable for sensory quality control?
K14	Does ingredient quality contribute to the sensory quality of the finished food product?
K15	Does preparation conditions contribute to the sensory quality of the finished food product?
Identifier	Question
	Attitude Section
	<i>(Options: Strongly disagree to Strongly agree- 1 to 5)</i>
A1	Taste and appearance are not important to consumer acceptance of food products
A2	I know the sensory attributes that are important for consumer acceptance of my company's products
A3	Consistent product sensory quality is not part of my job responsibility
A4	I have a clear role in maintaining consistent product sensory quality
A5	My company believes that consumer satisfaction depends on consistent sensory quality
A6	My company provides the tools needed to make products of consistent sensory quality
A7	These are common benefits of the implementation of a sensory quality control programme, please select their level of importance to your company from 1=least important to 5=most important
A7_1	Reduce customer complaints
A7_2	Increase sales
A7_3	Improve product sensory quality
A7_4	Reduce waste
A7_5	Encourage employees to take responsibility for product quality
A8	These are common barriers to the implementation of a sensory quality control programme, please select their level of importance to your company from 1=least important to 6=most important
A8_1	Low sensory expertise
A8_2	Consumes too much time
A8_3	Too expensive
A8_4	Not enough facilities
A8_5	Low company management interest
A8_6	Low employee interest
	Practices Section
	<i>(Response options)</i>
P1	How often is sensory evaluation training carried out for company staff? <i>1. Never 2. Once a year 3. More than once a year</i>
P2	How often is sensory quality testing carried out for each of your company's products? <i>1. Anytime 2. Based on requests 3. Based on planned schedule</i>
P3	How would you describe the sensory quality standards for your company's products? <i>1. No standard 2. Memorized standard 3. Standard is documented and readily available</i>
P4	Who coordinates the sensory evaluation activities at your company? <i>1. Staff with no sensory training 2. An external organisation 3. Staff with sensory training</i>
P5	Who carries out product sensory tests? <i>1. Staff with no sensory training 2. Staff with little sensory training 3. Staff that are highly trained for product sensory evaluation</i>
P6	What products are assessed as part of sensory quality control in the company? <i>1. Samples from product development 2. Raw materials 3. In-process materials 4. Finished products</i>
P7	Where are the products assessed? <i>1. No specific area(Anywhere that is comfortable) 2.Specified test area 3.Company's sensory laboratory</i>

P8 How are products of unsatisfactory sensory quality managed at your company?
1. No specific procedure 2. Documented procedure 3. Documented procedure with trend analysis

APPENDIX 2: Expert recommendations and comments (n=6)

Question	Recommendations/ Comments	Actions
D1	Please include the word phrase in question 1 where it says please choose which ... best describes ...	Not adopted as the question is clear
D1	You may need to include an 'other' response for some questions	Adopted this option was included for D1 and D7
D4	Could you clarify that this refers to the number of the entire staff of the company, not e.g., the section where the person works	Not adopted as the question is clear
D7	It might also be useful to include a box like this one after some important questions to get valuable comments.	Adopted for D1 and D7
K5	Some may not know what palate cleansing is. Would it be fair to give in brackets “e.g., rinsing mouth with water”)	Adopted- example given
K11	Question is complicated- rephrase	Adopted- question rephrased
A1	This question is double barrelled, select only one descriptor	Adopted
A7 and A8	Questions A7 and A8 should be rating scales instead of ranking scales as they are more informative	Adopted- Question were rephrased
P3	Question is complicated- rephrase	Adopted- rephrased

APPENDIX 3: Recommendations and comments from the pretest (intended users n=9)

Question	Recommendations/ Comments	Actions
D1	There could be an option where you combine more than 1 option. Some positions have multiple functions.	Not adopted- the main role is the focus
D1	It should have a "Management" as an option.	Adopted- management was added
D4	Not sure if you are asking how many people are employed in the company or division etc.	Not adopted- the question is clear
D5	Maybe African regions will be better.	Not adopted- the questionnaire can be used anywhere
D6	Not everyone is privileged to know this. A person working in the technical department might not have access to this information unless they are at a very high position.	The question was removed to prevent respondents from guessing
K2	Elaborate on meaning of basic tastes.	Not adopted as the question is to test sensory evaluation knowledge
K3	Will replacing the term "feel" with "texture" not be clearer and more specific?	Adopted as the researchers considered the question
K5	Elaborate on the meaning of palate cleansing.	An example was given as the knowledge of the process was the test
K8	Elaborate when stating test methods such as triangle test.	Not adopted as familiarity of the method was the test
K10	Question comes off very complicated.	Adopted- Question was rephrased
K11	Complicated question.	Adopted- Question was rephrased
K12	Question not clear- rephrase	Adopted- Question was rephrased
A3	"Consistent" is an odd word to use here. Something is either part of your responsibility and measured and controlled or it is not.	Not adopted as the term is used here to refer to product characteristics and not respondent's job responsibility
A5	"Tools" is a bit restrictive. Maybe use equipment, procedures and environment controls".	Adopted- Some examples of tool were given
A6	Products should be replaced with materials/products in question. change flow of answers. 2, 1, 3 and 4.	Adopted- Question was rephrased
P7	Products assessed for what? answers not specific. specified test area and company sensory lab could be same.	Adopted/ Not adopted- Question was rephrased, the answer options are sufficient

APPENDIX 4: Sensory quality control knowledge, attitude and practices questionnaire

This questionnaire assesses knowledge, attitude and practices with regards to sensory quality control

Respondents and company characteristics section

1. Please choose which option best describes your main current job function?
 1. Sales/ Marketing
 2. Production/ Manufacturing
 3. Quality Assurance
 4. Research & Development
 5. Others, please specify

2. Please choose which option best describes your current job level?
 1. Entry Level
 2. Intermediate
 3. Middle Management
 4. Senior Management
 5. Owner/Executive

3. Is your company a part of another larger company (a subsidiary)?
 1. Yes
 2. No

4. What is the total number of employees working in your company?
 1. Less than 10
 2. 10 to 50
 3. 51 to 200
 4. More than 200

5. In which country is your company located?
A relevant list of countries are provided

6. How many products does your company produce? (Includes different formulations but excludes different pack sizes of the same product)
 1. Less than 3
 2. 3 to 5
 3. 6 to 10
 4. More than 10

7. Please select the food processing sector your company belongs to? (if more than one sector, please choose the most important)
 1. Baked goods/confectionery
 2. Beverages
 3. Cereals and grains
 4. Dairy
 5. Frozen and/or chilled

6. Fruits and vegetables
 7. Meat and/or fish and/or sea food
 8. Oils and fats
 9. Sauces and condiments
 10. Others (please specify)
8. Do you have a quality department?
1. Yes
 2. No
9. Have you heard of sensory evaluation before this study?
1. Yes
 2. No
10. Was there any customer complaint/s or reprocessing of a product/s due to unacceptable sensory quality in the last 12 months?
1. Yes
 2. No
 3. I don't know
11. Which of the following sensory related functions are you involved in? (You can select more than one option)
1. None
 2. I request sensory experiments
 3. I plan sensory experiments
 4. I participate in sensory experiments
 5. I analyse sensory data and/or write reports
 6. I make decisions based on sensory data

Knowledge Section

The order of questions in this section should be randomised.

Key to correct answers: 1. (1), 2. (1), 3. (1), 4. (2), 5. (1), 6. (1), 7. (2), 8. (2), 9. (1), 10. (1), 11. (2)

Basic senses/ physiology

1. Can you perceive the aroma of food while it is in your mouth?
 1. Yes
 2. No
 3. I don't know

2. Is umami one of the basic tastes?
 1. Yes
 2. No
 3. I don't know

3. Can product texture be judged with the eyes?
 1. Yes
 2. No

3. I don't know

Good sensory practices

4. Will a food taster be able to judge product flavour if he/she has a cold or the flu?

1. Yes
2. No
3. I don't know

5. Is palate cleansing (e.g. rinsing mouth with water) a good sensory practice?

1. Yes
2. No
3. I don't know

6. Is it important to inform food tasters of allergens in the food they will be tasting?

1. Yes
2. No
3. I don't know

7. Should preference questions be asked during descriptive sensory tests?

1. Yes
2. No
3. I don't know

8. Should people without sensory evaluation training be used for sensory quality control tests?

1. Yes
2. No
3. I don't know

Sensory/ sensometric methods

9. Is a triangle test a sensory discrimination method?

1. Yes
2. No
3. I don't know

10. Is a one tailed hypothesis suitable for analysing the results of a triangle test?

1. Yes
2. No
3. I don't know

11. Is t-test used for analysing sensory differences between more than two products?

1. Yes
2. No
3. I don't know

Attitude Section

On a scale of 1 to 5 where 1 = Strongly Disagree, 2= Disagree, 3 = Neither Disagree nor Agree, 4 = Agree and 5 = Strongly Agree, indicate the extent to which you agree with each of the following statements.

S/N		1	2	3	4	5
1	I know the sensory attributes that are important for consumer acceptance of my company's products					
2	Maintaining product sensory quality is not part of my job responsibility					
3	I have a clear role in maintaining consistent product sensory quality					
4	My company believes that consumer satisfaction depends on consistent sensory quality					
5	My company provides the tools (equipment, procedures and/or training) needed to make products of consistent sensory quality					

6. These are common benefits of the implementation of a sensory quality control programme. Please indicate the level of importance of each to your company: 1=not important to 5=extremely important

		1	2	3	4	5
i	Reduce customer complaints					
ii	Increase sales					
iii	Improve product sensory quality					
iv	Reduce waste					
v	Encourage employee to take responsibility for product quality					

7. These are common barriers to the implementation of a sensory quality control programme. Please indicate the level of importance of each to your company: 1=not important 5= extremely important

		1	2	3	4	5
i	Low sensory expertise					
ii	Consumes too much time					
iii	Too expensive					
iv	Not enough facilities					
v	Low company management interest					
vi	Low employee interest					

Practice section

Does your company carry out sensory quality control?

1. Yes
2. No

If your answer was ‘Yes’, then please complete the rest of the questionnaire, if ‘No’ please do not complete the rest of the questionnaire.

1. How often is **sensory evaluation training** carried out for company staff?
 1. Never
 2. Once a year
 3. More than once a year
2. When is **sensory quality testing** carried out for each of your company’s products?
 1. Anytime
 2. Based on requests
 3. Based on a planned schedule
3. How does your company define the target sensory quality of products for quality control purposes?
 1. There is no defined standard
 2. It is based on a memorized standard
 3. The standard is documented and readily available
4. Who coordinates sensory quality control at your company?
 1. Staff with no sensory training
 2. An external organisation
 3. Staff with sensory training
5. Who carries out sensory quality tests?
 1. Staff with no sensory training
 2. An external organisation
 3. Staff with sensory training
6. What materials/products are assessed as part of sensory quality control in the company?
(Please choose from the list below, you can choose more than one option)
 1. Samples from product development
 2. Raw materials
 3. In-process materials
 4. Finished products
7. Where are the products assessed for sensory quality control?
 1. No specific area (Anywhere that is comfortable)
 2. A specified test area
 3. Company’s sensory laboratory
8. How are products of unsatisfactory sensory quality managed at your company?
 1. No specific procedure

2. A documented procedure
3. A documented procedure with trend analysis

Thank you for participating in this survey

APPENDIX 5: Sensory quality control knowledge, attitude and practices questionnaire

This questionnaire assesses knowledge, attitudes and practices with regards to sensory quality control in food companies.

Respondents and company characteristics section

1. Please choose which option best describes your main current job function?
 - a) Production/ Manufacturing
 - b) Quality Assurance
 - c) Research & Development
 - d) Sales/ Marketing
 - e) Other, please specify
2. Please choose which option best describes your current job level?
 - a) Entry level
 - b) Intermediate level
 - c) Middle Management
 - d) Senior Management
 - e) Owner/Executive
3. Is the company where you work part of another larger company (i.e., a subsidiary)?
 - a) Yes
 - b) No
4. In which country is the company where you work located?
A relevant list of countries is provided
5. What is the total number of employees in the company where you work?
 - a) 1 to 10
 - b) 11 to 49
 - c) 50 to 249
 - d) 250 and above
6. How many products are produced at the company where you work? (the number includes different formulations but excludes different pack sizes of the same product)
 - a) 1 to 2
 - b) 3 to 5
 - c) 6 to 10
 - d) 11 and above
7. Please select the food processing sector that is most relevant for the company where you work (if more than one sector, please choose the most relevant)
 - a) Baked goods/confectionery
 - b) Beverages
 - c) Cereals and grains
 - d) Dairy
 - e) Frozen and/or chilled
 - f) Fruits and vegetables
 - g) Meat and/or fish and/or sea food
 - h) Oils and fats

- i) Sauces and condiments
 - j) Other (please specify)
8. Do you have a quality department at the company where you work?
- a) Yes
 - b) No
9. Have you heard of sensory evaluation before this study?
- a) Yes
 - b) No (display the definition below)

Sensory quality of a product is how the product smells, looks, tastes and feels

Sensory evaluation is the use of the human senses to evaluate a product under standardized conditions

10. Was there any customer complaint/s or reprocessing of your company's product/s due to unacceptable sensory quality in the last 12 months?
- a) Yes
 - b) No
 - c) I don't know
11. How often were there complaints or reprocessing of products due to unacceptable sensory quality in the last 12 months? (displayed if yes is selected above)
- a) Rarely
 - b) Occasionally
 - c) Often
 - d) All the time
 - e) I don't know
12. What were the likely causes of unacceptable sensory quality? (You can select more than one option)
- a) Ingredient issues
 - b) Processing issues
 - c) Quality control issues
 - d) Storage and distribution issues
 - e) Others (please specify)
13. Which of the following sensory related functions are you involved in? (You can select more than one option)
- a) None
 - b) I request sensory tests
 - c) I plan sensory tests
 - d) I participate in sensory tests
 - e) I analyse sensory test data and/or write reports
 - f) I make decisions based on sensory tests
14. How much sensory evaluation related (requesting, planning, participating, analysis, or decision making) experience do you have?
- a) None

- b) Less than 1 year
 - c) 1 to 5 years
 - d) 6 to 10 years
 - e) More than 10 years
15. Have you received sensory evaluation training?
- a) None
 - b) Yes, in house sensory evaluation training
 - c) Yes, sensory evaluation training at an academic institution
 - d) Yes, Other sensory evaluation training (please specify) _____

Knowledge Section

Scored 1 for correct (green font) or 0 for incorrect and I don't know answers

The order of questions in this section should be randomized.

Basic senses/ physiology

1. Can a person smell a food while chewing it in the mouth?
 - a) **Yes**
 - b) No
 - c) I don't know

2. Is vanilla (sweet, salty, bitter, sour, umami, fruity) one of the basic tastes?
 - a) **Yes**
 - b) No
 - c) I don't know

3. Does the sense of hearing contribute to the evaluation of texture when eating an apple?
 - a) **Yes**
 - b) No
 - c) I don't know

4. Which one of these relates to the perception of sight?
 - a) **Rods**
 - b) Triangles
 - c) Squares
 - d) I don't know

5. Which one of these does trigeminal sensation relate to?
 - a) Visual perception
 - b) Auditory perception
 - c) **Flavour perception**
 - d) I don't know

6. Which one of these is perceived on the tongue?
- a) Volatile food compounds
 - b) Water soluble compounds
 - c) Bud binding compounds
 - d) I don't know

Good sensory practices

1. Is palate cleansing (e.g. rinsing mouth with water) between tasting different samples a good sensory practice?
 - a) Yes
 - b) No
 - c) I don't know
2. Should sensory quality panellists be informed of allergens in the food they will be tasting?
 - a) Yes
 - b) No
 - c) I don't know
3. Should product liking questions be asked during sensory quality control?
 - a) Yes
 - b) No
 - c) I don't know
4. How do you reduce carry over effects from one sample to the next when evaluating many samples?
 - a) By evaluating samples under red light
 - b) By taking rest periods between samples
 - c) By switching sides (left then right) in the mouth during chewing
 - d) I don't know
5. Which one of these can be ignored when recruiting panellists for sensory quality control of dairy products?
 - a) Their availability for product evaluation
 - b) Their interest in sensory quality control
 - c) Their level of liking of dairy products
 - d) I don't know
6. Should a panellist be asked to judge the flavour of products if he/she has a cold or the flu?
 - a) Yes
 - b) No
 - c) I don't know

Sensory quality control

1. Should employees with **no** sensory evaluation training be used for sensory quality control of products?
 - a) Yes
 - b) **No**
 - c) I don't know

2. A trained sensory panel has been carrying out sensory quality testing of bread for the past seven months. Which of the following is a way to check the panel performance?
 - a) Monitoring the scores for samples from different batches
 - b) **Monitoring the scores for control samples**
 - c) Monitoring the time used for product evaluation
 - d) I don't know

3. Which one of these tasks must be completed individually by members of a sensory quality panel?
 - a) Identification of reference standards for sensory descriptors
 - b) Selection of sensory descriptors for quality control purposes
 - c) **Evaluation of product samples for quality control purposes**
 - d) I don't know

4. A product sensory specification is...?
 - a) A list of ingredients that affect the sensory quality of the product
 - b) **The description of the target sensory properties of the product**
 - c) The description of the method used to evaluate the product
 - d) I don't know

5. The decision to reject/accept a product for release to the market based on its sensory quality depends on ...?
 - a) The results of the most senior panellist
 - b) The results of the most experienced panellist
 - c) **The results of all the panellists**
 - d) I don't know

6. In which order should product sensory attributes be evaluated during sensory quality control?
 - a) The order of sensory attributes should be varied from one sample to another
 - b) **The order of sensory attributes should be the same from one sample to another**
 - c) The order in which sensory attributes are evaluated does not matter
 - d) I don't know

Sensory/ sensometric methods

1. Is a paired comparison test a descriptive sensory method?
 - a) Yes

- b) No
 - c) I don't know
2. Which one of the following is suitable for testing whether two samples are different?
- a) Triangle test
 - b) Quad test
 - c) Square test
 - d) I don't know
3. Can a t-test be used to compare the sweetness ratings of two products?
- a) Yes
 - b) No
 - c) I don't know
4. Company Z's policy states that white bread that differs from the product specification ($p < 0.01$) should be rejected. The sensory quality of Sample X differs from the product specification ($p = 0.05$), should it be rejected?
- a) Yes
 - b) No
 - c) I don't know
5. Which of the following is the most suitable number of panellists for descriptive sensory evaluation?
- a) 3
 - b) 5
 - c) 10
 - d) I don't know
6. Which of the following tests would be suitable to determine the nature of differences between two brands of apple juice?
- a) Duo-trio test
 - b) Paired preference test
 - c) Descriptive analysis
 - d) I don't know

Attitude Section

Indicate the extent to which you disagree/agree with the following statements from strongly disagree - strongly agree

Employee attitudes

Scored 1 to 5 for strongly disagree - strongly agree, some questions (denoted R) are reverse worded.

S/N		Strongly disagree	Disagree	Neither agree/disagree	Agree	Strongly agree
1	Sensory quality of products is important to consumers					
2R	Sensory quality control is not reliable					
3	Employees are responsible for maintaining consistent sensory quality of products					
4R	Sensory quality control is a waste of time					
5	Sensory quality control is important					
6R	Employees do not need training on the sensory quality of products					

Indicate the extent to which you disagree/agree with the following statements about your company from Strongly Disagree - Strongly Agree

Company attitude

Scored 1 to 5 for strongly disagree - strongly agree, some questions (denoted R) are reverse worded.

S/N		Strongly disagree	Disagree	Neither agree/disagree	Agree	Strongly agree
1	My company maintains that consumer satisfaction depends on the sensory quality of products					
2	My company provides the resources needed to make products of good sensory quality					
3R	My company maintains that sensory quality control hinders production					
4R	My company regards sensory evaluation training as unnecessary					

5R	My company is reluctant to change operations to improve product sensory quality					
6R	My company regards safe products to be of good sensory quality					
7	My company produces products of consistent sensory quality					

Practice section

Does your company carry out sensory quality control?

3. Yes
4. No
5. I don't know

If your answer was 'Yes', then please complete the rest of the questionnaire, if 'No' please do not complete the rest of the questionnaire.

Practices section

Scored 1 to 3 for worst (a) to best practice (c)

1. How often is **sensory evaluation training** carried out for company staff?
 - a) Never
 - b) Once a year
 - c) More than once a year
2. When is **sensory quality testing** carried out for company products?
 - a) Anytime (based on convenience of the quality team)
 - b) When there is a problem or complaint
 - c) Based on a planned schedule
3. How does your company define the target sensory quality of products for quality control purposes?
 - a) There is no defined standard/specification
 - b) It is based on a memorized standard/specification
 - c) The standard/specification is documented and readily available
4. Who manages sensory quality control at your company?
 - a) Company staff with no sensory training
 - b) Company staff with some sensory training
 - c) Company staff with good sensory training and experience

5. Who evaluates the products for sensory quality control?
 - a) Panellist with no sensory training
 - b) Panellist with some sensory training
 - c) Panellist with good product-specific sensory training
6. What materials/products are evaluated as part of sensory quality control in your company? (Please choose from the list below, you can choose more than one option)
 - a) Raw materials
 - b) In-process materials
 - c) Finished products
7. Where is product sensory quality testing carried out?
 - a) No specific area (Anywhere that is comfortable/available)
 - b) A specified test area
 - c) Company's sensory laboratory
8. How are products of unsatisfactory sensory quality handled at your company?
 - a) No specific procedure
 - b) Based on a documented procedure
 - c) Based on a documented procedure with corrective actions
9. Does your company check product sensory quality before releasing products to the market?
 - a) No
 - b) Yes, sometimes
 - c) Yes, always

APPENDIX 6: Informed consent form (Pilot study)

Welcome to this study!

Ms Ogheneyoma Onojakpor, a PhD student at the University of Pretoria is carrying out research on sensory quality control in food companies. Your response will provide valuable insight into the limitations and opportunities for implementing good sensory quality control practices. It will also facilitate the identification of training needs for the adoption of good sensory practices. This study was approved by the ethics committee of the Faculty of Natural and Agricultural Sciences, University of Pretoria (Reference number 180000041).

The survey should take you about 15 minutes to complete. Your participation is voluntary. You may refuse to take part or exit the survey at any time without penalty or having to provide a reason. Your survey responses will be collected anonymously, no one will be able to identify you or your responses. You will not receive any remuneration for your participation, however, you may enter a prize draw to win a Sensory textbook by providing your email address at the end of the survey.

If you would like to discuss about this research, please contact the investigators:
Research supervisor (Prof HL De Kock): +27 12 420 3238 or riette.dekock@up.ac.za
Doctoral student (Ogheneyoma Onojakpor): +27 78 524 2897 or u18239634@tuks.co.za

By selecting the 'I agree' button below, you acknowledge the following:

- You have read the above information and understand it
- You are 18 years of age or older
- You voluntarily agree to participate in this survey
- You indemnify the university and its employees and/or students of against any liability related to your participation in this survey

I agree (begin the study)

I do not agree (do not begin the study)

APPENDIX 7: Informed consent form (Validation study)

You are invited to participate in a study on sensory quality control in food companies. This is part of the PhD study of Ogheneyoma Onojakpor at the University of Pretoria, South Africa. This questionnaire should be completed by food company employees in production, quality assurance/ control and research and development roles. Your responses will provide valuable insight to improve practices in food companies.

This questionnaire will take about 20 minutes to complete. You may provide your email address at the end of the survey to win one of four R500 shopping vouchers. Your participation in this study is voluntary and anonymous. The data collected is confidential and will only be used for research purposes. This study was approved by the Ethics Committee of the University of Pretoria. The researchers and the University are bound by their legal and professional responsibilities.

If you have any questions about the research, please contact the researchers:

Research supervisor (Prof HL De Kock): riette.dekock@up.ac.za

PhD student (Ogheneyoma Onojakpor): u18239634@tuks.co.za

By selecting Yes below, you provide consent to participate and agree to the following:

- I have read and understood the information about the study.
 - I voluntarily agree to participate in this survey.
 - I am aware that the information obtained in the study, will be anonymously processed, and used for research purposes only.
- Yes, I volunteer to take part in this study
- No, I do not volunteer to take part in this study

APPENDIX 8: Online questionnaire (Qualtrics) for validation study

Start of Block: SURVEY INSTRUCTION

Start of Block: Informed Consent

Q1 You are invited to participate in a study on sensory quality control in food companies. This is part of the PhD study of Ogheneyoma Onojakpor at the University of Pretoria, South Africa. This questionnaire should be completed by food company employees in production, quality assurance/ control and research and development roles. Your responses will provide valuable insight to improve practices in food companies. This questionnaire will take about 20 minutes to complete. You may provide your email address at the end of the survey to win one of four R500 shopping vouchers. Your participation in this study is voluntary and anonymous. The data collected is confidential and will only be used for research purposes. This study was approved by the Ethics Committee of the University of Pretoria. The researchers and the University are bound by their legal and professional responsibilities. If you have any questions about the research, please contact the researchers: Research supervisor (Prof HL De Kock): riette.dekock@up.ac.za PhD student (Ogheneyoma Onojakpor): u18239634@tuks.co.za By selecting Yes, below you provide consent to participate and agree to the following: I have read and understood the information about the study. I voluntarily agree to participate in this survey. I am aware that the information obtained in the study, will be anonymously processed, and used for research purposes only.

- Yes, I volunteer to take part in this study
- No, I do not volunteer to take part in this study

Page Break

End of Block: Informed Consent

Start of Block: Employee and company characteristics

This questionnaire assesses knowledge, attitudes and practices with regards to sensory quality control in food companies.



C1 Please choose which option best describes your main current job function?

- Sales/ Marketing
 - Production/ Manufacturing
 - Quality Assurance
 - Research & Development
 - Others, please specify _____
-



C2 Please choose which option best describes your current job level?

- Entry Level
 - Intermediate level
 - Middle Management
 - Senior Management
 - Owner/Executive
-



C3 Is the company where you work part of another larger company (i.e. a subsidiary)?

- Yes
- No



C4 In which country is the company where you work located?

▼ Afghanistan ... Zimbabwe



C5 What is the total number of employees in the company where you work?

- 1 to 10
 - 11 to 49
 - 50 to 249
 - 250 and above
-



C6 How many products are produced at the company where you work? (*the number includes different formulations but excludes different pack sizes of the same product*)

- 1 to 2
 - 3 to 5
 - 6 to 10
 - 11 and above
-



C7 Please select the food processing sector that is most relevant for your company? (*if more than one sector, please choose the most important*)

- Baked goods/confectionery
 - Beverages
 - Cereals and grains
 - Dairy
 - Frozen and/or chilled
 - Fruits and vegetables
 - Meat and/or fish and/or sea food
 - Oils and fats
 - Sauces and condiments
 - Others (please specify) _____
-



C8 Do you have a quality department at the company where you work?

- Yes
 - No
-



C9 Have you heard of sensory evaluation before this study?

(Sensory quality of a product is how the product smells, looks, tastes and feels. Sensory evaluation is the use of the human senses to evaluate a product under standardized conditions)

- No
- Yes



C10 Was there any customer complaint/s or reprocessing of your company's product/s due to unacceptable sensory quality in the last 12 months?

- Yes
- No
- I don't know

Display This Question:

If Was there any customer complaint/s or reprocessing of your company's product/s due to unacceptabl... = Yes



C11 How often were there complaint/s or reprocessing of product/s due to unacceptable sensory quality in the last 12 months?

- Rarely
- Occasionally
- Often
- All the time

Display This Question:

If Was there any customer complaint/s or reprocessing of your company's product/s due to unacceptabl... = Yes



C12 What were the likely causes of unacceptable sensory quality? (You can select more than one option)

- Ingredient issues
 - Processing issues
 - Quality control issues
 - Storage and distribution issues
 - Others (please specify)
-



C13 Which of the following sensory related functions are you involved in? (You can select more than one option)

- None
 - I request sensory tests
 - I plan sensory tests
 - I participate in sensory tests
 - I analyse sensory test data and/or write reports
 - I make decisions based on sensory tests
-



C14 How much sensory related experience do you have?

- None
 - Less than 1 year
 - 1 to 5 years
 - 6 to 10 years
 - More than 10 years
-



C15 Have you received any sensory evaluation training?

- No
 - Yes, in house sensory evaluation training
 - Yes, sensory evaluation training at an academic institution
 - Yes, Other sensory evaluation training (please specify)
-

Page Break

End of Block: Employee and company characteristics

Start of Block: Knowledge Assessment

The following questions relate to your knowledge of sensory evaluation principles and practices. Please note that your responses are anonymous.



K1 Can a person smell a food while chewing it in the mouth?

- Yes
 - No
 - I don't know
-



K2 Is vanilla one of the basic tastes?

- Yes
 - No
 - I don't know
-



K3 Does the sense of hearing contribute to the evaluation of texture when eating an apple?

- Yes
 - No
 - I don't know
-



K4 Which one of these does trigeminal sensation relate to?

- Visual perception
 - Auditory perception
 - Flavour perception
 - I don't know
-



K5 Which one of these relates to the perception of sight?

- Rods
 - Triangles
 - Squares
 - I don't know
-



K6 Which one of these is perceived on the tongue?

- Volatile food compounds
 - Water soluble compounds
 - Bud binding compounds
 - I don't know
-



K7 Is palate cleansing (e.g., rinsing mouth with water) between tasting different samples a good sensory practice?

- Yes
 - No
 - I don't know
-



K8 Should sensory quality panellists be informed of allergens in the food they will be tasting?

- Yes
 - No
 - I don't know
-



K9 Should product liking questions be asked during sensory quality control?

- Yes
 - No
 - I don't know
-



K10 How do you reduce carry over effects from one sample to the next when evaluating many samples?

- By evaluating samples under red light
- By taking rest periods between samples
- By switching sides (left then right) in the mouth during chewing
- I don't know



K11 Which one of these can be ignored when recruiting panellists for sensory quality control of dairy products?

- Their level of liking of dairy products
- Their availability for product evaluation
- Their interest in sensory quality control
- I don't know



K12 Should a panellist be asked to evaluate the flavour of products if he/she has a cold or the flu?

- Yes
- No
- I don't know

Page Break



K13 Should employees with **no** sensory evaluation training be used for sensory quality control of products?

- Yes
 - No
 - I don't know
-



K14 A trained sensory panel has been carrying out sensory quality control testing of bread for the past seven months. Which of the following is a way to check the panel performance?

- Monitoring the scores for samples from different batches
 - Monitoring the scores for control samples
 - Monitoring the time used for product evaluation
 - I don't know
-



K15 Which one of these tasks must be completed individually by members of a sensory quality panel?

- Identification of reference standards for sensory descriptors
 - Selection of sensory descriptors for quality control purposes
 - Evaluation of product samples for quality control purposes
 - I don't know
-



K16 A product sensory specification is...?

- A list of ingredients that affect the sensory quality of the product
 - The description of the target sensory properties of the product
 - The description of the method used to evaluate the product
 - I don't know
-



K17 The decision to reject/accept a product for release to the market based on its sensory quality depends on ...?

- The results of the most senior panellist
 - The results of the most experienced sensory panellist
 - The results of all the panellists
 - I don't know
-



K18 In which order should product sensory attributes be evaluated during sensory quality control?

- The order of sensory attributes should be varied from one sample to another
 - The order of sensory attributes should be the same from one sample to another
 - The order in which sensory attributes are evaluated does not matter
 - I don't know
-



K19 Is a paired comparison test a descriptive sensory method?

- Yes
 - No
 - I don't know
-



K20 Which one of the following is suitable for testing whether two samples are different?

- Triangle test
 - Quad test
 - Square test
 - I don't know
-



K21 Can a t-test be used to compare the sweetness ratings of two products?

- Yes
 - No
 - I don't know
-



K22 Company Z 's policy states that white bread that differs from the specification ($p < 0.01$) should be rejected. The sensory quality of Sample X differs from the product specification ($p = 0.05$), should it be rejected?

- Yes
- No
- I don't know



K23 Which of the following is the most suitable number of panellists for descriptive sensory evaluation?

- 3
- 5
- 10
- I don't know



K24 Which of the following tests would be suitable to determine the nature of differences between two brands of apple juice?

- Duo-trio test
- Paired preference test
- Descriptive analysis
- I don't know

Page Break

End of Block: Knowledge Assessment

Start of Block: Attitude/ perception assessment



A1 Please indicate the extent to which you disagree/ agree with the following statements, from strongly disagree - strongly agree

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Sensory quality of products is important to consumers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sensory quality control is not reliable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Employees are responsible for maintaining the sensory quality of products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sensory quality control is a waste of time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sensory quality control is important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Employees do not need training on the sensory quality of products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



A2 Please indicate the extent to which you disagree/ agree with the following statements about your company, from strongly disagree - strongly agree

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
My company maintains that consumer satisfaction depends on the sensory quality of products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company provides the resources needed to make products of good sensory quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company maintains that sensory quality control hinders production	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company regards sensory evaluation training as unnecessary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company is reluctant to change operations to improve product sensory quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company regards safe products to be of good sensory quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My company produces products of consistent sensory quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

End of Block: Attitude/ perception assessment

Start of Block: SQC



Does your company carry out sensory quality control?

- yes
- No
- I don't know

End of Block: SQC

Start of Block: Practice assessment



P1 How often is sensory evaluation training carried out for company staff?

- Never
 - Once a year
 - More than once a year
-



P2 When is sensory quality testing carried out for each of your company's products?

- Anytime (based on convenience of the quality team)
 - When there is a problem or complaint
 - Based on a planned schedule
-



P3 How does your company define the target sensory quality of products for quality control purposes?

- There is no defined standard/specification
 - It is based on a memorized standard/specification
 - The standard/specification is documented and readily available
-



P4 Who manages the sensory quality control at your company?

- Company staff with no sensory training
 - Company staff with some sensory training
 - Company staff with good sensory training and experience
-



P5 Who evaluates products for sensory quality control?

- Panellists with no sensory training
 - Panellists with some sensory training
 - Panellists with good product-specific sensory training
-



P6 What materials/products are evaluated as part of sensory quality control in your company?

(Please choose from the list below, you can choose more than one option)

- Raw materials
 - In-process materials
 - Finished products
-



P7 Where is product sensory quality testing carried out?

- No specific area (anywhere that is comfortable/ available)
 - A specified test area
 - Company's sensory laboratory
-



P8 How are products of unsatisfactory sensory quality handled at your company?

- No specific procedure
 - Based on a documented procedure
 - Based on a documented procedure with corrective actions
-



P9 Does your company check product sensory quality before releasing products to the market?

- No
- Yes, sometimes
- Yes, always

End of Block: Practice assessment

Start of Block: Block 7

LD Would you like to participate in the lucky draw?

- Yes
- No

End of Block: Block 7
