Development and pilot testing of a questionnaire to assess sensory quality control (SQC) knowledge, attitudes and practices (KAP) of food company employees

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Abstract

Sound sensory evaluation knowledge and attitude are central to the successful development and implementation of a sensory quality programme. This study focused on the development and pilot testing of a questionnaire to assess the sensory quality control (SQC) knowledge, attitudes and practices (KAP) of food company employees. The initial questionnaire consisted of 43 questions divided into four sections: respondent and company characteristics, knowledge, attitudes and practices. Six subject matter experts and eight food company employees reviewed the questions for content validity and clarity. The questionnaire was modified and a pilot test (n = 56) was carried out to determine the psychometric properties of the questionnaire. The final revised questionnaire with 37 questions had acceptable content validity and clarity. The knowledge questions showed acceptable difficulty and discrimination indices, item-total correlation ranged from 0.3 to 0.9 for both the attitudes and practices sections. Exploratory factor analysis led to the retention of three factors for attitudes and one factor for the practices sections, respectively. Cronbach's α ranged from 0.6 to 0.9. The questionnaire is a tool that can be used to rapidly identify gaps in SQC knowledge and attitudes of food employees, as well as to identify areas of improvement of a company's SQC system.

Keywords: Sensory quality control; Questionnaire development; Knowledge, attitudes and practices; food companies

1. Introduction

The sensory quality of a food product is one of the most important considerations that drive product selection, purchase and consumption (Costell, 2002, Hansen, Petersen & Byrne, 2005). It may also be an indicator of food safety, quality of raw materials and processing conditions thus contributing to the perceived value of a food product (Varzakas & Tzia, 2015). Sensory defects are the leading cause of customer complaints and have also been linked to food losses and waste (Dzung, Dzuan & Tu 2003). Some customers may not complain, but will choose a different product in the future, resulting in loss of sales and brand equity.

Quality control (QC) encompasses the set of procedures that ensure the compliance of products and processes to set standards through monitoring and the implementation of remedial actions where necessary (Mitra, 2016). Although QC is widely practiced in the food industry, several authors have reported low or marginal uptake of sensory quality control (SQC) (Munoz, 2002; Kilcast, 2010; Endrizzi, Aprea, Biasioli, Corollaro, Demattè, Penasa, Bittante & Gasperi, 2013). Reasons for this include cost constraints, time constraints, inadequate expertise and limited management support. Furthermore, there is paucity of published studies on SQC. This may be because SQC studies require collaboration with food companies with limited time and funds for such research (Saguy, 2011; Jackson, 2015) or that many prefer to keep such research confidential and proprietary to the company. Literature has highlighted the use of unsuitable sensory methods, untrained assessors and inappropriate standards as limitations to the success of sensory evaluation programs (Costell, 2002; Kilcast, 2010). Adequate sensory evaluation knowledge is key to addressing these limitations (Stone and Sidel, 2004).

Knowledge potentially influences individual attitudes and beliefs, and eventually behaviour (Schrader & Lawless, 2004; De Pretto, Acreman, Ashfold, Mohankumar & Campos-Arceiz,

2015). It facilitates deductive reasoning and thus helps to acquire further information (Schrader & Lawless, 2004). Quantitative knowledge, attitude and practices (KAP) data can be cost-effectively collected at multiple locations simultaneously using questionnaires. The findings could unveil weaknesses and strengths of processes and can facilitate optimization strategies (Schrader & Lawless, 2004; Launiala, 2009). Pilot testing of questionnaires is necessary to ensure that the data to be collected will be relevant, accurate and reproducible (Hair, Anderson, Babin & Black, 2010; Jones, Lamp, Neelon, Nicholson, Schneider, Swanson & Zidenberg-Cherr, 2015). Both the validity (accuracy of the questionnaire) and the reliability (consistency of the measurements obtained) need to be ascertained (Singh, 2017). Three types of validity tests are typically considered: content, construct and criterion validity (Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003; Sarmugam, Worsley & Flood, 2014; Singh, 2017). Content validation reflects the extent to which the questions are representative of the construct/subject of interest and construct validity relates to the degree to which the test measures the theoretical construct of interest. Criterion validity evaluates the relationship between performance on the test and another related established criterion (the gold standard) (Rubio et al., 2003; Boateng, Neilands, Frongillo, Melgar-Quiñonez and Young, 2018). Reliability is commonly assessed as the Cronbach's α coefficient, which is a measure of the relatedness of the questions (Tavakol and Dennick, 2011; Cho and Kim, 2015).

Most KAP studies collect self-reported employee data, as employees are the possessors of organizational knowledge (Birasnav, 2014). Employees should also report on organizational culture and practices, as these influence employee attitude and the application of knowledge (Doorewaard and Benschop, 2003; Ansari-Lari, Soodbakhsh & Lakzadeh, 2009). Furthermore, some practices (e.g. SQC) are implemented at the organizational level and thus do not depend solely on the knowledge of the employee.

While several valid and reliable food safety and nutrition KAP instruments exist, none could be found for SQC. The only study found was a survey carried out by the Sensory Evaluation Division (SED) of the Institute of Food Technologists in 2001 and 2002 reported by Stone and Sidel (2004). The SED online survey focused on the 'function of sensory within a company', evaluating the sensory methods used but did not cover the minimal requirements for sensory evaluation programmes. The questionnaire was neither validated nor its development documented. The aim of this study was to develop and pilot test a tool to assess SQC related KAP in food companies. The questionnaire could be used to evaluate the sensory evaluation KAP of food company employees, highlighting gaps and providing baseline information for interventions around improvement in SQC. External organisations may also use the level of compliance of the company to good sensory evaluation practices to evaluate its commitment to product sensory quality.

2. Methods

2.1. Ethical Approval

The ethics committee of the University of Pretoria approved the study (EC 180000041). All respondents provided consent. No remuneration was provided for respondents other than an entry to a draw to win a sensory evaluation textbook. The questionnaire was pilot tested in three studies (**Figure 1**). Data were collected in English.

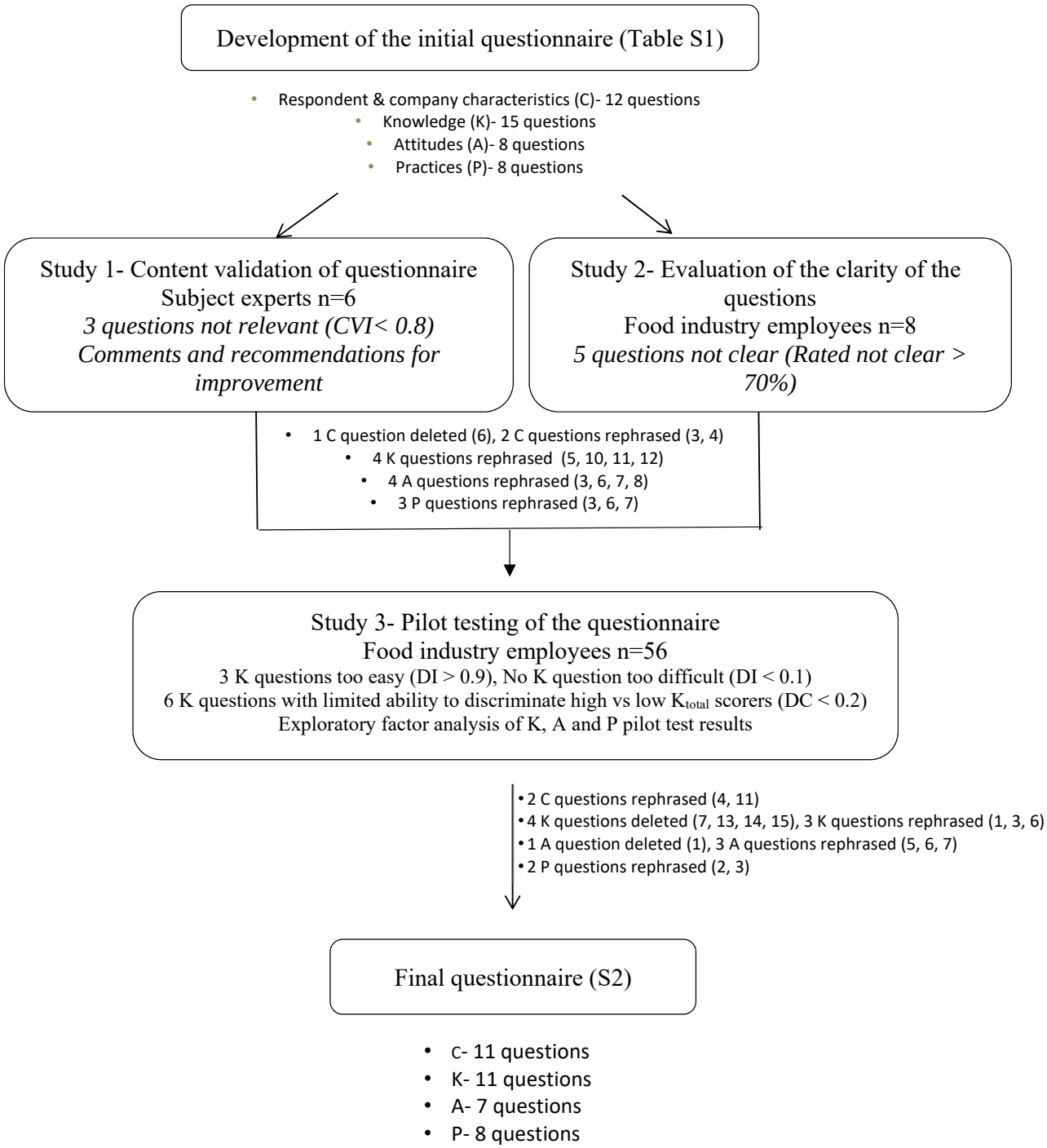

Figure 1. Development and pilot testing of a questionnaire to assess sensory quality control (SQC) knowledge, attitudes and practices (KAP) of food company employees

CVI = content validation index; ICC = Intra-class correlation coefficient DI = difficulty index; DC = discrimination index

2.2. Initial questionnaire

The self-administered questionnaire was developed from published scientific literature, other questionnaires and books on sensory evaluation and psychometrics. The initial questionnaire (Table S1) consisted of 43 questions which are divided into four sections: respondents and company characteristics, knowledge, attitudes and practices.

2.2.1. Respondents and company characteristics section

Selected characteristics of the respondents and their employers such as their main job function, sensory evaluation related job functions, the size of the company, the number of products manufactured, company location etc. were collected using 12 multiple choice questions. These questions (C1- C12) are shown in Table S1. The options for company size were based on the number of employees as per the World Trade Organisation definitions (WTO, 2016).

2.2.2. Knowledge section

This consisted of 15 questions with three response options: 'yes', 'no' and 'I don't know'. The 'I don't know' option was added to differentiate incorrect knowledge from lack of knowledge and to decrease the probability of a respondent opting for the right answer by chance (Agüeria, Terni, Baldovino & Civit, 2018). The knowledge section covered sensory science topics such as senses/sensory physiology, sensory methods, good sensory practices, statistics and SQC (Table S1).

2.2.3. Attitudes Section

The attitude of respondents and their perceptions of their company's disposition towards SQC were measured with eight questions (Table S1). Respondents rated their level of agreement to six attitude statements (A1 to A6) using a five-point Likert scale (1 = strongly disagree to 5 =

strongly agree) and for two questions (A7 and A8) ranked the level of importance of various statements from least to most important.

2.2.4. Practices Section

The respondents' perceptions of the compliance of their company with good SQC practices were assessed using eight multiple-choice questions (Table S1). The three answer options covered a range of practices with varying compliance to good practice regarding sensory evaluation and SQC (Stone and Sidel, 2004 and Lawless and Heymann, 2010). Practices assessed included the standards used, nature of panellists, test location and the frequency of product evaluations.

2.3. Study 1- Content validation

As shown in Figure 1, the initial questionnaire (43 questions) was content validated by six sensory evaluation experts, three academics, two industry scientists and one consultant. Three of the experts had over ten years and the other three between five and ten years of experience. The experts individually rated whether or not each of the questions was relevant to the research issue under investigation using a five-point Likert scale (1 = strongly disagree to 5 = for strongly agree). The content validity index (CVI) of each question was calculated as the ratio of the number of experts that gave a relevance rating >3 (k) to the total number of experts, therefore $\frac{k}{6}$. A question was considered relevant if CVI > 0.8 (Rubio et al., 2003; Dos Santos, Riner & Henriques, 2019). The experts were also asked to make recommendations for improving the questionnaire.

The reliability of the expert ratings was computed as the Intra-class correlation coefficient (ICC) consistency measure derived from a 2-way mixed effects ANOVA model (IBM SPSS

version 25). Reliability (ICC values) was categorized as poor (<0.50), moderate (0.50 to 0.75), good (0.76 to 0.90) or excellent (>0.90) (Rubio et al., 2003: Koo & Li, 2016).

2.4. Study 2- Clarity test

The clarity of the initial questionnaire was pre-tested by eight conveniently selected food industry professionals from Nigeria and South Africa with varying sensory evaluation related functions (Figure 1). Respondents were given a brief description of the study and the URL link to the online survey. For each of the 43 questions, respondents individually answered yes or no to the question- 'Is this question clear?' Eight respondents were used to account for varying perceptions regarding question clarity, each question was considered clear if at least six of the eight respondents (>70 %) answered yes. The respondents could also make comments and recommendations.

2.5. Study 3 - Pilot test

The initial questionnaire was modified (13 questions were rephrased, 1 removed) based on studies 1 and 2. The revised questionnaire was then pilot tested by another convenience sample of food company employees from Ethiopia, Nigeria and South Africa. Recruitment was carried out using snowball sampling, respondents were recruited face-to-face or via email or LinkedIn and interested persons were asked to forward the invitation to complete the questionnaire to their food industry contacts. Data were exported from the survey platform (Qualtrics, Provo, United States of America) as an SPSS data file.

Responses to the respondent and company characteristics section were used for profiling the respondents. Responses to the knowledge questions were scored as described in Sarmugam et al., (2014). Correct answers to the knowledge questions were scored '1' (shown in Table 1),

while 'I don't know' and wrong answers were scored '0'. Answers to the attitude questions (A1 to A6) were scored 1-5 (strongly disagree - strongly agree), the scores were reversed for A1 and A3 as they were negatively phrased. Answers to the practices questions were scored

Table 1. Knowledge (K) questions difficulty level and ability to discriminate between low and high K_{total} scorers in the pilot test (study 3, n = 56 respondents)

No.	Question *Response options: Yes, No, I don't know*	Correct answer	Difficulty index (DI) (0.1-0.9)	Discrimination index (DC) (≥0.2)
K1	Can you smell food while it is in your mouth?	Yes	0.70	0.64
K2	Is umami one of the basic tastes?	Yes	0.25	0.64
K3	Can product feel be judged with the eyes?	Yes	0.64	0.36
K4	Should you judge product flavour if you have a cold/flu?	No	0.89	0.14
K5	Is palate cleansing (e.g. rinsing mouth with water) a good sensory practice?	Yes	0.89	0.21
K6	Should food tasters know the allergens in the food they will be tasting?	Yes	0.88	0.14
K7	Is the order of presenting samples important during sensory tests?	Yes	0.93	0.07
K8	Is a triangle test a sensory discrimination method?	Yes	0.43	0.57
K9	Should preference questions be asked during descriptive sensory tests?	No	0.20	0.36
K10	Is a one tailed alternative hypothesis suitable for analysing the results of a triangle test?	Yes	0.16	0.29
K11	Is a t-test used for analysing sensory differences between more than two products?	No	0.11	0.29
K12	Should people without sensory evaluation training be used for sensory quality control tests?	No	0.68	0.43
K13	Are consumer preference tests suitable for sensory quality control?	No	0.13	0.07
K14	Does ingredient quality contribute to the sensory quality of the finished food product?	Yes	1.00	0.00
K15	Does preparation conditions contribute to the sensory quality of the finished food product?	Yes	0.98	0.07

DI = the proportion of respondents who answered correctly over the total n, criteria for acceptance 0.1 to 0.9

DC = proportion of respondents 'correct' high K_{total} scorers group (upper 25th percentile) minus low K_{total} scorers group (the lower 25th percentile), a value ≥ 0.2 considered acceptable (Chen, Soo, Ab Rahman, Rostenberghe & Harith, 2013).

1-3, except for question P6 (what materials/ products are assessed as part of sensory quality control in your food company?) where a score of '1' was awarded for each of the options selecting raw materials, in-process materials or finished goods and '0' for samples from product development. The sum of scores for knowledge and practices sections were used to determine the total scores (K_{total} and P_{total}). For the attitude section, A_{total} is the sum of scores for questions A1 to A6.The performance of respondents on the different sections were categorized as poor <50%, good (50% – 74%) and very good ≥75%. All statistical analyses were performed using IBM SPSS version 25, unless stated otherwise.

The difficulty indexes (DI) of the knowledge questions were determined as the proportion of respondents who answered correctly, the criteria for acceptance was 0.1 to 0.9 (Whati, Senekal, Steyn, Nel, Lombard and Norris, 2005; Underhill-Blazey, Stopfer, Chittenden, Nayak, Lansang Lederman, Garber & Gundersen,.2019). The discrimination indexes (DC) of the knowledge questions were determined by subtracting the proportion of respondents who answered correctly in the low K_{total} scorers group (the lower 25th percentile) from that of the high K_{total} scorers group (upper 25th percentile) (Boateng et al., 2018), a value ≥ 0.2 was considered acceptable (Chen, Soo, Ab Rahman, Rostenberghe & Harith, 2013).

Construct validity was assessed by comparing the K_{total} scores of respondents with sensory evaluation related functions and those without and also respondents with prior awareness of sensory evaluation and those without using the Mann-Whitney U test (Sarmugam et al., 2014). It was expected that the former groups in both pairs would score higher on the knowledge section. Respondents were segmented based on their responses to the questions 'Have you heard about sensory evaluation prior to this study?' (C10 in Table S1) and 'Which of the following sensory related functions are you involved in?' (C12 in Table S1), respectively.

Spearman's rho coefficient was used to evaluate the relationship between K_{total} and A_{total} scores of respondents (Sarmugam et al., 2014).

Construct validity of all sections were evaluated by exploratory factor analysis (EFA) using the principal axis factoring (PAF) method (Leech, Barrett and Morgan, 2015). The Kaiser Meyer Olkin measure of sampling adequacy (KMO MSA) and Bartlett's test of sphericity were assessed as outputs of the EFA prior to factor retention to test the degree of correlation between the questions and the sufficiency of the data collected. The benchmarks for acceptability were >0.5 and < 0.05, respectively (Watson, 2017). The number of factors retained was determined by multiple criteria: Kaiser's eigenvalue, scree test, parallel analysis and Velicer's minimum average partial (MAP) test (Boateng et al., 2018). The reliability of the retained factors were computed as Cronbach α and their relatedness as corrected item to total correlations (ITC), values ≥ 0.70 and ≥ 0.2, respectively, were considered satisfactory (Ducak and Keller, 2016; Boateng et al., 2018; Taber, 2018).

3. Results and Discussion

3.1. Content validation by experts (Study 1)

The experts considered three questions (C3, C4 and K13) irrelevant to the assessment of the SQC KAPs as highlighted in Figure 1. K13 was removed while C3 and C4 were retained as these were deemed important to form a complete profile of respondents' companies. All other questions were considered relevant (CVI > 0.80).

The ICC value was 0.954 (excellent), indicating that the ratings for the different questions by the different experts were very similar. The experts also gave some recommendations such as

rephrasing questions C4, K5, K11, A1 and P3 and changing the response options for questions A7 and A8 from ranking to a rating scale, these were effected.

3.2. Clarity test (Study 2)

Five knowledge questions (K2, K3, K5, K10 and K11) were deemed 'unclear' as less than 70% of respondents rated them as clear (Figure 1). It is possible that different respondents applied different criteria to determine whether a question was phrased clearly or not. Three questions (K2, K5 and K11) may have been unclear due to unfamiliar terms, e.g. one respondent stated for K2 'I answered no as I am unfamiliar with the term used'. Comments for K11 were 'Maybe include what is meant by a t-test' and 'Not everyone in industry working with sensory evaluation understands statistical terms'. The terms were retained as they were considered necessary to test advanced level sensory evaluation knowledge. Questions C4, K3, K5, K10, K11, K12, A6, P6 and P7 were rephrased to improve clarity based on respondents' rating and recommendations. A comment by one respondent –' Not everyone is privileged to know this', led to the deletion of question C6 (Estimate the annual projected/ real gross income of your company?).

3.3. Pilot test (Study 3)

A total of 71 responses were collected and 56 responses were analysed. Responses were included if the respondent completed the respondent and company characteristics section and at least one of the KAP sections. Fifty-one respondents had completed all sections and an additional five respondents completed the respondent and company characteristics section and at least one of the KAP sections. Analyses were carried out separately for the different sections. Most of the responses (n = 61) were collected online via the survey platform Qualtrics, while 10 respondents completed printed copies of the questionnaire. The median online survey

completion time was 13 minutes 27 seconds. Most of the respondents (70%) completed the online survey within 18 minutes; this is longer than the 15 minutes completion time estimated by the researchers. Two respondents contacted the researchers and complained of difficulty with moving from one section to the next online. This may have been due to poor internet connection possibly contributing to the attrition rate, thus, emphasizing the importance of paper-based surveys (Couper, 2000).

3.3.1. Characteristics of pilot test respondents and their companies

Of the 56 respondents, four (7%) worked for microenterprises (less than 10 employees), 33 (59%) for large food companies (over 250 employees) and 19 (34%) for small and medium companies. 49 respondents worked in quality or production departments and 7 respondents worked in marketing or other departments. Eight respondents (12%) had neither heard of sensory evaluation nor reported that their companies practiced SQC. This number is of importance as three of these respondents worked in large companies with assumingly access to funds and expertise to carry out SQC. The respondents also had job roles (two working in quality assurance and two in production) where SQC are generally considered important (Lawless and Heymann, 2010). Customer complaints due to unacceptable sensory quality of products in the last 12 months were reported by 38% (21) of the respondents. The question related to customer complaints (C11) is important as it might highlight the potential consequences of an inadequate SQC programme and may indicate the need for improvement in the management of product sensory quality in companies. Due to the relatively small number of respondents and convenience sampling procedure, it is not possible nor the intention here to draw inferences about the larger population. The convenient recruitment strategy applied was not targeted to include only employees that are directly involved with control of sensory quality

in companies, thus, survey results were interpreted with consideration for respondents' job roles.

3.3.2. Assessment of SQC knowledge

Eleven of the respondents (20 %) had poor knowledge (K_{total} <50%), 40 (71%) had good knowledge (K_{total} between 50% and 75%) and five respondents (9%) had excellent knowledge (K_{total} >75%). The DI of three questions (K7, K14 and K15) were > 0.9 (**Table 1)**, reflecting that the questions were too easy and therefore not appropriate for testing the knowledge level of the respondents. The DI of each question is equivalent to its mean. Two questions (K14 and K15) were related to SQC: 'Does ingredient quality contribute to the sensory quality of the finished food product?' and 'Does preparation conditions contribute to the sensory quality of the finished food product?'. This indicates that most respondents understand the contribution of raw materials and preparation conditions to the sensory quality of the finished product. The third question (K7) was related to good sensory evaluation practices: 'Is the order of presenting samples important during sensory tests?'. No question had a DI < 0.1, so none was too difficult. However, the DI of five questions (K2, K9. K10, K11 and K13) (Table 1) were below 0.3 indicating substantial difficulty. Both K10 and K11 relate to the use of statistics to analyse sensory data and K9 and K13 relate to sensory methods in quality control indicating potential knowledge gaps in these areas as previously reported by Costell (2002) and Stone and Sidel (2004).

Six questions (K4, K6, K7, K13, K14, K15) (Table 1) had DC < 0.2 indicating a limited ability to discriminate between high and low K_{total} scorers (Dickson-Spillmann, Siegrist & Keller, 2011; Jones et al., 2015). The determination of the DC is useful in question selection during

questionnaire development. Questions with both DC and DI values that do not fall within the acceptable ranges were removed from the questionnaire, thus, K7, K14 and K15 were deleted.

As expected, respondents who had heard of sensory evaluation prior to this study had higher K_{total} scores ($p = 0.04$) than those that were unaware of the discipline (**Table 2**). Those familiar with sensory evaluation may have had relevant training and/or experience. Contrary to expectation, respondents with sensory evaluation related functions did not score higher ($p = 0.24$) than those without involvement in such functions. The respondents who were not involved in sensory evaluation related functions at the time, may have also received sensory evaluation training or served such functions at some other stage.

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Table 2. Comparison of total knowledge questions scores (K_{total}) of respondent groups (study 3 pilot testing n=56 respondents) with different awareness of and involvement with sensory evaluation

	Group	n	Median	U-value
Prior awareness of sensory evaluation (C10)	Yes	48	9	0.04
	No	8	6	
Involvement in sensory evaluation related functions (C12)	Yes	48	9	0.24
	No	8	6	

Preliminary assessment of the knowledge section to test its suitability for EFA revealed unacceptable KMO MSA of 0.444 and Bartlett's test of sphericity of 0.236, therefore factor analysis was not pursued further. These measures indicate a limited degree of correlation between the questions and limitations regarding the sufficiency of the data collected. This outcome is comparable to previous questionnaire development studies on nutrition knowledge where factor analysis was not carried out (Dickson-Spillmann et al., 2011; Sarmugam et al., 2014 and Jones et al., 2015). However, the authors did not give reasons for their decisions. The low KMO MSA indicates the need to include more subject related questions and/or a larger sample of respondents (Hair et al., 2010) to improve the correlation between questions and

their suitability for factor analysis. An insignificant Bartlett's test may indicate the need to improve the correlation between questions by dividing the section into subsections to account for the distinct knowledge aspects (Taber, 2018) such as statistics, good sensory practices and physiology of the senses.

3.3.3. Assessment of food employees' attitudes towards SQC

Respondents displayed positive attitude towards SQC with 48 out of 53 (91%) scoring above 74% of the maximum A_{total} (sum of A1 to A6) and the remaining five (9%) scoring above 49%. EFA was carried out for the attitudes section to evaluate the relationship between the questions in this section. KMO MSA for the attitudes section was initially 0.67 and Bartlett's test of sphericity was significant ($p<0.0001$), indicating an acceptable level of common variance among the questions (Watson, 2017). Factor analysis revealed a five-factor solution (Eigenvalues > 1), a three-factor solution (scree plot and parallel analysis) or two-factor solution (Velicer's MAP test) for the attitudes section. Forced extractions of two and three factors using the varimax rotation, which allows for correlation between factors, were carried out. This led to the retention of the three-factor solution (Table 3) based on the best logical interpretation (Watson, 2017). Barriers to the implementation of SQC take up the first factor, benefits of SQC the second, and the employee and company attitude statements the third. The three factors 1, 2 and 3 accounted for 24%, 19% and 10% of the total variance (Table 3), respectively, i.e. a total of 53% which is within the expected range of 50-60% that is commonly reported for similar studies (Williams, Onsman & Brown 2010). The factors retained were representative of the sub-sections: employee or company attitudes, benefits and barriers to the implementation of SQC (**Table 3**). Examination of the factor loadings and reliability analysis led to the removal of question A1, as it did not load significantly on any factor (-0.15) and it had a negative ITC value (-0.04). Respondents may have misinterpreted the question as it was

the first for this section and it was reverse worded. After the deletion of question A1 the KMO MSA increased to 0.69, indicating better correlation between the questions (Watson, 2017).

Cronbach's α for the sub-categories barriers and benefits of the implementation of SQC were 0.81 and 0.82 respectively (Table 3). These indicate good inter-relatedness between the questions in each sub-category. The values also suggest a substantial contribution of each question to the total section performance and the absence of or a low degree of measurement errors (Tavakol and Dennick, 2011; Taber, 2018). The values are similar to the internal consistencies observed in the development of the nutrition KAP questionnaire by Chen et al. (2013). The Cronbach's α coefficient for the employee/company attitudes sub-scale was 0.62. This indicates a lesser common variance among the questions compared to the other two sub-categories. It may also be an indication of the complexity of the questions due to their focus on both personal and corporate attitudes (**Table 3**). Further improvement of these questions is desirable to better assess employee/ company attitudes.

There was a statistically insignificant correlation ($r = 0.08$, $p = 0.28$) between the K_{total} and A_{total} scores. The lack of a significant correlation may be because the attitudes section assessed both the respondent and their company while the knowledge questions focused on the respondent. Several authors (Munoz 2002; Findlay, 2002; Kilcast, 2010) have discussed the importance of management support in the successful implementation of SQC, howbeit not frequently discussed is the role of employee support and motivation. There may be some resistance to change from employees during the introduction of a new system or optimization of an existing one, some employees may consider SQC as additional work. Thus, it was important to consider attitude on both fronts: the company and the employees.

Table 3. Exploratory factor analysis (EFA) and internal consistency (Cronbach's alpha) of the attitudes (A) questions in the pilot test (study 3)

No	Question Response options: Strongly disagree to Strongly agree (1-5)	Median	Factors (Loadings >0.3)			Item-total correlation (>0.2)
			1	2	3	
A1	Taste and appearance are not important to consumer acceptance of food product	5			-0.15	-0.04
A2	I know the sensory attributes important for consumer acceptance of my company's products	4			0.37	0.32
A3	Maintaining product sensory quality is not part of my job responsibility	5		0.31	0.38	0.40
A4	I have a clear role in maintaining consistent product sensory quality	4			0.63	0.57
A5	My company believes that consumer satisfaction depends on consistent sensory quality	4			0.47	0.34
A6	My company provides the tools (equipment, procedures etc.) needed to make products of consistent sensory quality	4			0.34	0.27
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=not important to 5=extremely important					
A7_1	Reduce customer complaints	5		0.73		0.68
A7_2	Increase sales	5		0.58		0.38
A7_3	Improve product sensory quality	5		0.57	0.43	0.60
A7_4	Reduce waste	4		0.72		0.66
A7_5	Encourage employees to take responsibility for product quality	5		0.78		0.70
A8	These are common barriers to the implementation of a sensory quality control programme. Please select their level of importance in your company from 1=not important to 5=extremely important					
A8_1	Low sensory expertise	4	0.63			0.59
A8_2	Consumes too much time	3	0.70		0.39	0.51
A8_3	Too expensive	3	0.57			0.50
A8_4	Not enough facilities	4	0.66		-0.33	0.64
A8_5	Low company management interest	4	0.72			0.63
A8_6	Low employee interest	3	0.67			0.61
	% Variance accounted for		24	19	10	
	Cronbach α		0.81	0.82	0.62	

3.3.4. Assessment of SQC practices

Of the 47 respondents who reported that their company implemented SQC, four respondents (9%) reported marginal practices (P_{total} < 50%), 12 (26%) reported good practices (P_{total} between 50 and 75%) and 31 (66%) reported very good practices (P_{total} >75%). Seventy-nine % of respondents reported that finished products were evaluated while 38% reported evaluating raw materials and 30% evaluating in-process materials as part of SQC (P6). Thirty eight percent of respondents indicated that product samples from product development were assessed as part of SQC in the company. For this group of respondents it is clear that more emphasis is placed on finished product testing than raw material and in-process testing. Munoz (2002), more than a decade ago, recommended to reduce over-reliance on end-product testing by implementing SQC at the ingredient and in-process level. For some products, sensory quality defects in finished goods may be reduced or prevented by adopting raw materials and/or in-process SQC testing. This strategy may also reduce consumer dissatisfaction and wastage associated with finished product sensory quality defects.

The relationships between knowledge or attitudes and practices were not explored further as the questionnaire assessed the practices of the food company, and this is not necessarily dependent on the knowledge or attitude of the employees. The positive attitude and practices reported in this study may have been exaggerated by the mostly unidirectional nature of the questions in both sections. Future efforts to balance the direction of the questions will be useful to address this bias.

EFA of the practices section revealed one factor (Eigenvalue of 5.59) which accounted for a total variance of 73% (Table 4). All questions loaded unto the one factor with good to excellent factor loadings ranging from 0.61 to 0.95 (**Table 4**). The KMO MSA was 0.91 indicating good

question sufficiency for the factor. Bartlett's test of sphericity was significant $p < 0.0001$, indicating that questions were related (Watson, 2017). The internal reliability of the practices section was excellent with a Cronbach's α value of 0.95, indicating that the questions were measuring a similar construct. The reliability demonstrated is in line with Cronbach's α coefficients for the practice sections of nutrition related KAP questionnaires by Chen et al. (2013) and Schaefer and Zullo (2016).

Table 4. Exploratory factor analysis (EFA) and internal consistency (Cronbach's alpha) of the practices (P) questions in the pilot test (study 3)

No.	**Question** *Response options(1 to 3)*	**Median**	**Factor loading (>0.3)**	**Item-total correlation (>0.2)**
P1	How often is **sensory evaluation training** carried out for company staff? *1. Never 2. Once a year 3. More than once a year*	2	0.79	0.76
P2	How often is **sensory quality testing** carried out for each of your company's products? *1. Anytime 2. Based on requests 3. Based on planned schedule*	3	0.79	0.75
P3	How does your company define the target sensory quality of products for quality control purposes? *1. No standard 2. Memorized standard 3. Standard is documented and readily available*	3	0.95	0.91
P4	Who coordinates sensory quality control at your company? *1. Staff with no sensory training 2. An external organisation 3. Staff with sensory training*	3	0.91	0.88
P5	Who carries out sensory quality tests? *1. An external organisation 2. Staff with no sensory training 3. Staff sensory training*	3	0.87	0.85
P6	What materials/products are assessed as part of sensory quality control in the company? *1. Samples from product development 2. Raw materials 3. In-process materials 4. Finished products*	1	0.61	0.59
P7	Where are the products assessed for sensory quality control? *1. No specific area (Anywhere that is comfortable) 2. Specified test area 3. Company's sensory laboratory*	2	0.84	0.79
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*	3	0.94	0.91
	% Variance accounted for		73	
	Cronbach α		0.95	

3.4. Implications of the use of the questionnaire

In general, the completion of the SQC KAP questionnaire could promote awareness of sensory evaluation among company employees thus fostering learning by making respondents conscious of what SQC entails. Respondents' scores for the different sections of the

questionnaire could be used to assess performance levels and to identify areas of non-conformance, training needs or attention to facilities and systems. For example, an anonymous respondent (R36) in the pilot survey scored K_{total} = 46%, A_{total} =77% and P_{total} =42%, respectively. The low score areas indicate the need for training of the employee and improvement of the SQC system of the company. The questionnaire could also be used to assess knowledge gains from training programs by comparing performance before and after training.

Technological advances in instruments and sensors (e.g. electronic nose and tongue, optical scanners), robotics and artificial intelligence are changing the way SQC is carried out in companies by addressing some inherent challenges of using human subjects (Hansen et al., 2005; Zhang, Zhang, Xie, Fan & Bai, 2008). Humans are limited in how many samples they can evaluate before fatigue sets in. Continuous and regular evaluation of some products increase the potential for health concerns. Availability of human assessors for on-line measurements is a challenge. Fast and efficient analysis of SQC data from human subjects requires expertise. The modern technologies may have an impact on the speed, accuracy and cost of SQC. Expertise is needed now more than ever to develop these methods and validate their performance against human assessments in the food industry (Findlay, 2002). The use of online survey collection platforms (Compusense Cloud, Qualtrics, SurveyMonkey® etc.), cheaper and faster internet access and dedicated statistical software applications may enhance the ease, accuracy and speed in questionnaire administration, data collection and analysis.

3.5. Limitations of the study and recommendations for further work

A major limitation of this study is the relatively small sample size of the pilot study in comparison to other questionnaire development studies where 120 (Uggioni and Salay, 2013)

and 153 respondents (Álvarez-García, Álvarez-Nieto, Pancorbo-Hidalgo, Sanz-Martos, and López-Medina, 2018) were used. However, the number of respondents in this study is similar to pilot studies by Dos Santos et al. (2019) and John, Treharne, Hale, Panoulas, Carroll, and Kitas, (2009) where 65 and 61 respondents were used, respectively. Continued refinement of the questionnaire and in particular the knowledge section to include more questions is desirable. Further testing of the questionnaire with more respondents is needed for higher reliability of the factor extraction (Osborne, Costello & Kellow, 2008). Furthermore, a test-retest reliability study could not be carried out as the questionnaire was completed anonymously. In future, comparison of measures of SQC KAPs with other external measures (e.g. product quality specifications compliance, consistency of product quality or consumer perception of the product quality) should be explored. Improvement in SQC KAPs as a result of training and other interventions can also be assessed. Confirmatory factor analysis with an independent, larger sample should also be carried out to statistically verify the factor structure derived from this study.

4. Conclusions

The study details the development and validation of a self-administered questionnaire for assessing the KAP of food company employees with regards to SQC. Thirty-seven questions were retained in the final questionnaire (shown in S2). The attitude and practices questions demonstrated acceptable content validity, construct validity and internal reliability. However, the pilot study revealed that the knowledge section needs further development. Food companies and relevant stakeholders will be able to use the questionnaire to rapidly evaluate the sensory quality knowledge and attitudes of their employees. It may be useful to identify knowledge gaps and evaluate the effectiveness of SQC training. It should be developed further and applied in future studies by other researchers.

Conflicts of interest

The authors have no conflict of interest with this work.

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