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# Sensory quality control: Assessment of food company employees' knowledge, attitudes, and practices

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## Abstract

This study was carried out to validate a questionnaire for assessing sensory quality control (SQC) knowledge, attitudes, and practices (KAP). The questionnaire, containing 24 knowledge, 13 attitudes, and nine practices items, was submitted to company representatives in South Africa and Nigeria. Confirmatory factor analysis and group comparisons among respondents and companies were carried out to validate the questionnaire. The final SQC-KAP questionnaire consists of 24 knowledge (one scale), 11 attitudes (A bifactor scale, with a general scale and two subscales representing individual attitudes to SQC and those towards company SQC) and nine practices (one scale) items. The knowledge items had acceptable indices for difficulty and discrimination, and the attitudes and practices items had acceptable item-total correlations. The final questionnaire can be used for the rapid assessment of SQC related knowledge and attitudes of food company employees and assessment of company practices.

## Practical Applications

This study is the first to validate a questionnaire for assessing SQC related knowledge, attitudes, and practices in the food industry. The SQC-KAP questionnaire can be used to rapidly assess SQC knowledge and attitudes of food company employees for sensory services, and to identify SQC training needs. Stakeholders can also use it to assess the sensory quality practices of food companies to gauge their compliance to good practice and identify potential areas of improvement of their SQC programs.

## 1 | INTRODUCTION

Sensory quality control (SQC) of ingredients and manufactured products usually rests on the shoulders of food company employees (Sensory Evaluation Division, 2002). SQC is usually not outsourced, as there is need for regular and timely evaluation of products for real time decisions (Kilcast, 2010). Hence, SQC expertise is essentials in food companies to support this function. The assessment of employees' SQC knowledge and targeted training are vital to the success of any sensory quality system. Intellectual and psychological assessments have been used widely in the food industry (especially in food safety) to assess and improve employee competence and performance (Nyarugwe, Linnemann, Nyanga, Fogliano, & Luning, 2018). Questionnaires are cost effective, easily administered tools that are popularly used in knowledge and behavioral assessments in the food industry (Guldenmund, 2007; Zanin, da Cunha, de Rosso, Capriles, & Stedefeldt, 2017). The development and validation of such questionnaires need to ensure the collection of relevant and useful data.

Very few studies have used questionnaires to investigate and document sensory evaluation practices in food companies. The

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Sensory Evaluation Division of the Institute of Food Technologists (IFT), (2002), collected responses on sensory evaluation related activities carried out in fast-moving consumer goods companies such as SQC, data analysis and consumer/preference testing. Brandt and Arnold (1977) documented the sensory evaluation tests used by food product development groups. The study revealed that most of the respondents (56 out of 62) carried out sensory evaluation, but there was limited understanding of the appropriate methods for different objectives (Stone & Sidel, 2004). The questionnaires used in both studies were not validated, and they did not assess SQC related knowledge and attitudes.

A SQC knowledge, attitudes, and practices (KAP) questionnaire was developed, and pilot tested in a previous study (Onojakpor & de Kock, 2020). The questionnaire was evaluated for face and content validity, and construct validity was tested by exploratory factor analysis and by comparing the performance of known groups (respondents who had received training versus those who had not) using a small group of respondents ($n = 56$). The questions were relevant to the assessment of SQC KAP. The knowledge questions showed acceptable difficulty and discriminated well between individuals with different levels of sensory evaluation knowledge. The study revealed that the knowledge questions ($k = 11$) could be increased to allow for better coverage of the subject, as there were only three or four questions on each of the three sub-topics (human senses, good sensory practices, and sensory methods). In addition, the uni-directional nature of the attitude statements may have introduced bias in the attitude scale. The low number of respondents may limit the validity of the results.

The objective of this follow-up study was to refine and validate the questionnaire for the collection of relevant and accurate data using a larger pool of respondents. Confirmatory factory analysis (CFA) was used to confirm construct validity. To demonstrate the quality of the KAP instrument, the performance of respondents and companies with different characteristics were compared (known groups comparisons) based on the following hypotheses (H1–H6).

**H1.** Respondents with good sensory evaluation knowledge (K) will have favorable sensory quality related attitudes (A) as knowledge is a determinant of attitude (Nyarugwe et al., 2018).

**H2.** Respondents with prior awareness of sensory evaluation will have higher knowledge (K) scores than those without.

**H3.** Respondents who have received sensory evaluation training will have better sensory evaluation knowledge scores (K) as training improves knowledge (Zanin et al., 2017).

**H4.** Respondents with more sensory evaluation experience will have better sensory evaluation knowledge scores (K) as knowledge improves with relevant experience.

**H5.** Large and medium sized companies will have better SQC practices (P) compared to small food companies as they have better access to expertise and funds compared to smaller companies (Carbonell-Barrachina, 2007).

**H6.** Food companies with good sensory practices (P) will have less customer complaints and product reprocessing due to sensory quality issues.

## 2 | MATERIALS AND METHODS

### 2.1 | Ethics approval

The study was approved by an ethics committee of the University of Pretoria (180000041). Informed consent was obtained from all respondents before participation. No remuneration was provided for respondents other than an entry to a draw to win a R500 online shopping voucher. The questionnaire was in English language.

### 2.2 | Questionnaire

The questionnaire consisted of 24 knowledge questions (Table 1), 13 attitude statements (Table 2) and nine practices questions (Table 3). The questionnaire by Onojakpor & de Kock (2020) was the basis, but new questions were added to different sections to cover the important sub-topics of SQC based on literature (Lawless & Heymann, 2010; Stone & Sidel, 2004) and the expertise of the authors. New questions were added to the knowledge section, bringing the total number of questions in each sub-topic to six. Negatively phrased attitude statements were added and the frequency of product sensory evaluations at the respondent's company was captured.

The respondent and their company characteristics section consisted of 15 questions (Appendix S1) collecting information such as the nature of the sensory evaluation training completed, years of sensory related experience and assessment of the frequency and causes of customer complaints at their food company.

The knowledge section (K) consisted of 24 questions which assess four key sensory areas (sub-sections): basic senses/physiology, good sensory practices, sensory quality control, and sensory/sensometrics methods (Appendix S2). Multiple choice questions with three possible answers (13 questions) and yes/no questions (11 questions) were used. An "I don't know" option was included to reduce the probability of respondents guessing the right answer. One (1) point was awarded for each correct response and zero (0) for "I do not know" or wrong responses (Sarmugam et al., 2014).

The attitudes section (A) consisted of 13 statements that assess employee attitude ($k = 6$) and their perception of the company SQC ($k = 7$) (Table 2). Respondents rated their level of agreement to each statement using a five-point Likert scale (strongly disagree = 1 to strongly agree = 5). Some statements (A1, A3, A5, A7, A8, and A13) were favorable

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**TABLE 1** The descriptive characteristics, difficulty, and discrimination indices of the knowledge (K) questions obtained by item response theory (IRT), $n = 345$

| No. | Question Correct = 1, incorrect/I do not know = 0 | Mean ± SD | % I do not know | Difficulty | Discrimination | Item fit |
|---|---|---|---|---|---|---|
| K1 | Can a person smell a food while chewing it in the mouth? | 0.7 ± 0.5 | 6 | −1.92 | 0.49 | 1.00 |
| K2 | Is vanilla one of the basic tastes? | 0.5 ± 0.5 | 8 | −0.10 | 1.19 | 0.22 |
| K3 | Does the sense of hearing contribute to the evaluation of texture when eating an apple? | 0.8 ± 0.4 | 5 | −1.86 | 0.76 | 0.46 |
| K4 | Which one of these relates to the perception of sight? | 0.4 ± 0.5 | 24 | 0.44 | 0.46 | 0.91 |
| K5 | Which one of these does trigeminal sensation relate to? | 0.5 ± 0.5 | 34 | 1.06 | 0.59 | 0.42 |
| K6 | Which one of these is perceived on the tongue? | 0.5 ± 0.9 | 11 | 2.76 | 0.31 | 0.31 |
| K7 | Is palate cleansing (e.g., rinsing mouth with water) between tasting different samples a good sensory practice? | 1.0 ± 0.2 | 3 | −3.60 | 1.06 | 0.25 |
| K8 | Should sensory quality panelists be informed of allergens in the food they will be tasting? | 0.9 ± 0.2 | 1 | −2.98 | 1.05 | 0.77 |
| K9 | Should product liking questions be asked during sensory quality control? | 0.4 ± 0.5 | 3 | 0.45 | 0.80 | 0.28 |
| K10 | How do you reduce carry over effects from one sample to the next when evaluating many samples? | 0.7 ± 0.5 | 13 | −1.06 | 0.82 | 0.46 |
| K11 | Which one of these can be ignored when recruiting panelists for sensory quality control of dairy products? | 0.5 ± 0.5 | 8 | −0.08 | 0.54 | 0.09 |
| K12 | Should a panelist be asked to judge the flavor of products if he/she has a cold or the flu? | 0.9 ± 0.3 | 3 | −2.17 | 1.31 | 0.88 |
| K13 | Should employees with no sensory evaluation training be used for sensory quality control of products? | 0.7 ± 0.4 | 3 | −1.69 | 0.64 | 0.92 |
| K14 | A trained sensory panel has been carrying out sensory quality testing of bread for the past 7 months. Which of the following is a way to check the panel performance? | 0.4 ± 0.5 | 7 | 0.45 | 1.34 | 0.52 |
| K15 | Which one of these tasks must be completed individually by members of a sensory quality panel? | 0.6 ± 0.5 | 7 | −0.61 | 1.04 | 0.40 |
| K16 | A product sensory specification is…? | 0.6 ± 0.5 | 1 | −0.62 | 1.16 | 0.48 |
| K17 | The decision to reject/accept a product for release to the market based on its sensory quality depends on …? | 0.8 ± 0.4 | 1 | −1.80 | 0.89 | 0.20 |
| K18 | In which order should product sensory attributes be evaluated during sensory quality control? | 0.5 ± 0.5 | 3 | −0.10 | 0.44 | 0.43 |
| K19 | Is a paired comparison test a descriptive sensory method? | 0.3 ± 0.5 | 11 | 1.06 | 0.87 | 0.07 |
| K20 | Which one of the following is suitable for testing whether two samples are different? | 0.6 ± 0.5 | 16 | −0.50 | 1.33 | 0.93 |
| K21 | Can a *t* test be used to compare the sweetness ratings of two products? | 0.6 ± 0.5 | 26 | −1.64 | 0.32 | 0.38 |
| K22 | Company Z's policy states that white bread that differs from the product specification ($p < .01$) should be rejected. The sensory quality of sample X differs from the product specification ($p = .05$), should it be rejected? | 0.3 ± 0.5 | 8 | 2.14 | 0.35 | 0.06 |
| K23 | Which of the following is the most suitable number of panelists for descriptive sensory evaluation? | 0.5 ± 0.5 | 9 | 0.00 | 0.87 | 0.92 |
| K24 | Which of the following tests would be suitable to determine the nature of differences between two brands of apple juice? | 0.3 ± 0.5 | 13 | 1.14 | 0.79 | 0.02 |

*Note*: See Appendix S2 for response options.

to SQC and others (A2, A4, A6, A9, A10, A11, and A12) not. The latter scores were reversed prior to analysis.

The practices section consisted of nine multiple-choice questions. Respondents selected from three practices, which were scored in order of increasing compliance to good sensory practices (Stone & Sidel, 2004). One (1) point was awarded for selecting the marginal/poor practice and three (3) points for the best practice.

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**TABLE 2** Comparison of total knowledge scores ($K_{total}$) of respondent groups ($n = 345$) with different characteristics using *t* test and analysis of variance

| Question | Group | *n* | Mean ± SD ($K_{total}$) | *p* (2 tailed) |
|---|---|---|---|---|
| Have you heard about sensory evaluation before this study? | No | 24 | 11.0 ± 3.8 | <.001 |
| | Yes | 321 | 14.1 ± 3.8 | |
| Have you received any sensory evaluation training? | No | 47 | 10.7 ± 3.6 | <.001 |
| | Yes | 298 | 14.4 ± 3.6 | |
| Do you have any sensory related job role? | No | 47 | 12.2 ± 3.7 | <.001 |
| | Yes | 298 | 14.2 ± 3.8 | |
| How much sensory evaluation related experience do you have? | None | 21 | 10.3 ± 3.7 | <.001 |
| | <1 | 60 | 12.7 ± 3.4 | |
| | 1–5 y | 159 | 13.9 ± 3.7 | |
| | 6–7 y | 45 | 14.8 ± 3.8 | |
| | >10 y | 60 | 15.9 ± 3.6 | |

Abbreviation: y, years.

**TABLE 3** The mean, SD, item-total correlation, factor loadings from confirmatory factory analysis (CFA), and Cronbach's α of the attitudes (A) questions, $n = 345$

| No. | Statements | Mean ± SD | Item-total correlation | CFA factor loading | | |
|---|---|---|---|---|---|---|
| | | | | General | Sub-factor 1 | Sub-factor 2 |
| A1 | Sensory quality of products is important to consumers | 4.5 ± 0.9 | 0.114 | – | – | – |
| A2[a] | Sensory quality control is not reliable | 4.1 ± 1.0 | 0.311 | 0.412 | 0.465 | – |
| A3 | Employees are responsible for maintaining consistent sensory quality of products | 3.8 ± 1. 2 | 0.151 | 0.192 | 0.206 | – |
| A4[a] | Sensory quality control is a waste of time | 4.6 ± 0.8 | 0.388 | 0.483 | 0.634 | – |
| A5 | Sensory quality control is important | 4.5 ± 1.0 | 0.256 | 0.354 | 0.401 | - |
| A6[a] | Employees do not need training on the sensory quality of products | 4.2 ± 1.0 | 0.367 | 0.389 | 0.390 | – |
| A7 | My company maintains that consumer satisfaction depends on the sensory quality of products | 4.1 ± 0.9 | 0.303 | 0.584 | – | −0.284 |
| A8 | My company provides the resources needed to make products of good sensory quality | 4.1 ± 1.0 | 0.360 | 0.731 | – | −0.250 |
| A9[a] | My company maintains that sensory quality control hinders production | 3.6 ± 1.2 | 0.331 | 0.414 | – | 0.553 |
| A10[a] | My company regards sensory evaluation training as unnecessary | 3.9 ± 1.2 | 0.448 | 0.679 | – | 0.202 |
| A11[a] | My company is reluctant to change operations to improve product sensory quality | 3.5 ± 1.2 | 0.422 | 0.551 | – | 0.475 |
| A12[a] | My company regards safe products to be of good sensory quality | 2.2 ± 1.2 | −0.053 | – | – | – |
| A13 | My company produces products of consistent sensory quality | 4.1 ± 0.8 | 0.336 | 0.615 | – | 0.142 |
| | Cronbach α | | | 0.691 | 0.504 | 0.663 |

[a]Scores were reversed. See Appendix S2 for response options.

## 2.3 | Respondents

An e-mail invitation to complete a questionnaire was sent to food industry employees through the major national associations for food science professionals in South Africa (South African Association for Food Science and Technology, *SAAFoST*) and Nigeria (Nigerian Institute of Food Science and Technology, *NIFST*). The food markets of both countries cover some 260 million consumers (Eze et al., 2021; Rispel, Marshall,

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Matiwane, & Tenza, 2021). The invitation was also shared via a digital food science newsletter in South Africa (www.foodfocus.co.za), and via food science related LinkedIn, Facebook, and WhatsApp groups. The invitation stated that the target respondents were food company employees in production, quality and research and development roles and the invitation could be forwarded to other food industry contacts.

A total of 503 responses were received, 345 responses were complete. Of these, 35 respondents (10%) could not answer one question (A13) as it was accidentally left out and only added after these respondents had completed the questionnaire. The missing data were imputed using the multiple imputation method (IBM SPSS, version 27; Lovik, Nassiri, Verbeke, Molenberghs, & Sodermans, 2017). Most respondents completed the questionnaire within 30 min with a median time of 19 min. For some respondents it may have taken longer to complete the questionnaire because of the lengthy employee and company characteristics section, which will be much shorter for an in-company assessment. Some respondents appear to have completed the questionnaire with extensive breaks in between.

## 2.4 | Data analysis

### 2.4.1 | Knowledge section

Item response theory (IRT) analysis was used to examine the underlying structure of the knowledge section using R mirt package version 1.33.2 (Albanese, Bütikofer, Armijo-Olivo, Ha, & Egger, 2020). IRT analysis is used to demonstrate the validity of tests by evaluating the difficulty and discrimination indices of the questions (Arifin & Yusoff, 2017). The unidimensionality of the model was determined by a modified parallel analysis, and the fit of each question to the model was determined using the root mean-square error of approximation (RMSEA). A non-significant $p$ value is desirable for both tests ($p > .05$) (Zahiruddin et al., 2018). Questions with difficulty levels from $-3$ to $+3$ are acceptable, where more negative values indicate easier questions and more positive values indicate more difficult questions (Zahiruddin et al., 2018, Ward et al., 2016). The discrimination index indicates the extent to which the question discriminates between respondents with different ability levels. Values from 0.35 to 2.50 are acceptable (Zahiruddin et al., 2018). Knowledge questions with unacceptable difficulty and discrimination indices were considered for removal from the questionnaire. Model fit was estimated using the M2 statistic, comparative fit index (CFI), root mean square error of approximation (RMSEA) and standardized root-mean-square residual (SRMR). The model is considered excellent or acceptable based on the following guidelines: CFI values ≥0.95 and ≥0.90, respectively; RMSEA and SRMR values ≤0.06 and ≤0.08, respectively (La Barbera et al., 2020; Ward et al., 2016).

### 2.4.2 | Attitudes and practices sections

Confirmatory factor analysis (CFA) was carried out using the R package lavaan (version 0.6–8) to determine if the structural relationship between the questions meet the expectation of a two factor and one factor model for the attitudes and practices sections, respectively. The diagonally weighted least square estimator (DWLS) was used, this is the default method for categorical data, and is also well suited for ordinal data (Holgado-Tello et al., 2009). The model fit was estimated using the CFI, RMSEA, and SRMR and interpreted using the threshold values described above. Chi-square indices were calculated but were not used for model selection as the measure has been shown to be biased for sample sizes above 200 (Román and Sánchez-Siles, 2018). The item-total correlations of the items in the attitudes and practices sections were computed, a value above 0.2 is desirable.

Construct validity was also examined by comparing the sum of scores for the knowledge ($K_{total}$) and practices ($P_{total}$) for different groups of respondents using Student's $t$ test and analysis of variance (ANOVA) (Stanifer et al., 2015) based on the hypotheses stated earlier. Fisher's least significant difference (LSD) test was used for the separation of means. Pearson's correlation coefficient was computed for the $K_{total}$ and total attitude ($A_{total}$) scores of respondents to determine any underlying relationship.

# 3 | RESULTS AND DISCUSSION

## 3.1 | Characteristics of respondents and their companies

Most respondents were from South Africa (52%) and Nigeria (35%) with 13% from India, The United States of America, United Kingdom, and other countries. Forty-three percent of the respondents worked in quality control/assurance, 27% in research and development, 15% in production/manufacturing, 6% in sales/marketing, and 9% in other roles. Most respondents (83%) reported that their companies carried out SQC, the remaining respondents (17%) reported that this was not the case, or they did not know if their company did. The characteristics of the respondents and their companies are shown in Appendix S1.

## 3.2 | Validation of the knowledge section

The difficulty of the 24 knowledge questions ranged from −3.60 for the easiest question (K7) to 2.76 for the hardest question (K6), indicating a good coverage of knowledge abilities (Table 1). The difficulty range of the knowledge questions suggests that the questionnaire will be an effective tool for assessing SQC knowledge. The discrimination power ranged from 0.31 (K6) to 1.34 (K14), indicating good discrimination between individuals of different levels of knowledge. Questions K6 and K21 had low discrimination abilities, 0.31 and 0.32, respectively, while question K7 had a low difficulty (i.e., too easy) (−3.60). All questions, except K24 fitted well with the unidimensional model. All 24 questions were retained as they either had a satisfactory difficulty or discrimination index or they had a good fit with the unidimensional model (Table 1). The unidimensionality of the knowledge

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section was supported by the modified parallel analysis ($p = .762$) (Zahiruddin et al., 2018).

The one-factor model had a good fit. Model fit indices were M2 = 220.70 (df = 189, $p < .013$), CFI = 0.94, RMSEA = 0.02 and SRMR = 0.05. The model also had an acceptable reliability as evidenced by a Cronbach's alpha of 0.70. A unidimensional model provides evidence that the total knowledge score can be computed as a measure of ability (Albanese et al., 2020). The 24 questions in the knowledge section were retained in the final questionnaire.

Total scores on the knowledge section ranged from 1 to 23, with a mean score of 14 (theoretical range 0–24). Most respondents (57%) had good knowledge ($K_{total}$ from 50% - 74%, scores from 12–17), 26% had poor knowledge ($K_{total}$ < 50%, scores <12) and 17% had excellent knowledge ($K_{total}$ ≥ 75%, scores ≥18). This indicates a wide range of knowledge levels with most respondents correctly answering more than half of the questions. This could be because those with sensory evaluation experience and training (86% of respondents in this study) are more likely to respond to the survey invitation than those without.

There was a significant correlation ($r = .24$, $p < .001$) between the $K_{total}$ and $A_{total}$ scores of respondents and between $K_{total}$ and sum of statements related to employee attitude (A1 to A6) ($r = .28$, $p < .001$). This is an indication that knowledge may be a driver of attitude. The link between knowledge and attitude is controversial. While some studies on food safety found a positive link (Al-Shabib, Mosilhey, & Husain, 2016; Ansari-Lari, Soodbakhsh, & Lakzadeh, 2010), others reported that knowledge did not translate into attitude (Zanin et al., 2017). Respondents who had heard of sensory evaluation prior to this study (C9-*Have you heard about sensory evaluation before this study*?) had higher $K_{total}$ scores ($p = .001$) than those who had not (Table 2). The $K_{total}$ scores of respondents with sensory evaluation training was higher than those with no training ($p < .001$). The $K_{total}$ scores of respondents with sensory related work experience was higher than those who were not involved in sensory evaluation ($p < .001$). This supports previous reports of a positive effect of training and experience on food safety knowledge (Agueria et al., 2018; Al-Shabib et al., 2016; Ansari-Lari et al., 2010).

### 3.3 | Validation of the attitudes section

Question A12 (*My company regards safe products to be of good sensory quality*) had a negative item-total correlation (ITC = −0.05) indicating that it did not contribute positively to the assessment of attitudes. Hence it was removed from the attitudes section in the final questionnaire version. The ITC of the other statements ranged from 0.11 to 0.45, with A1 and A3 below 0.2 (Table 3) thus indicating a minimal contribution to the assessment of attitudes. A1 (ITC = 0.11) was removed as it assessed respondent's perception of consumer attitude towards product sensory quality and is thus not directly related to the other statements.

Based on the theoretical construct of the attitude section, the data was expected to fit one of the following models.

1. A two-factor model with statements loading based on whether they relate to employee or company SQC.
2. A bifactor model with a general factor and two specific factors for statements relating to the employee and company SQC.

Examination of the models revealed a poor fit for the two-factor model, $\chi^2 = 191.86$ (df = 43, $p < .001$), CFI = 0.89, RMSEA = 0.10 and SRMR = 0.07; the factors were correlated (0.67). The bifactor model had an acceptable fit, $\chi^2 = 76.02$ (df = 33, $p < .001$), CFI = 0.97, RMSEA = 0.06 and SRMR = 0.05. A one factor model was explored and as expected it had a poor fit, $\chi 2 = 326.62$ (df = 54, $p < .001$), CFI = 0.80, RMSEA = 0.12 and SRMR = 0.10. The source of the two-factor model misfit was explored by inspecting the interitem correlation matrix, the factor loadings, correlational residuals, and modification indices (Knekta, Runyon, & Eddy, 2019). The acceptable SRMR suggests that item-to-item correlation may not have contributed substantially to the misspecification (Knekta et al., 2019). Statement A3 had a low factor loading (0.285) indicating that it was not well explained by the factor and possibly contributed to the high RMSEA value (Arnold & Fletcher, 2015). Examination of the modification indices and correlated residuals revealed some unexplained relationships between a few statements, the highest was between A9 and A11 (correlation residual = 0.227). This is likely due to similar meanings of the statement. Addition of this correlation residual to the model resulted in an acceptable model fit, $\chi^2 = 117.39$ (df = 42, $p < .001$), CFI = 0.94, RMSEA = 0.07 and SRMR = 0.06.

The bifactor model had a better fit than the two-factor model as the specific factors accounted for some variance not captured by the general factor (average factor loading = 0.49). This is especially important for the statements relating to individual attitude as the average loading on that specific factor was 0.42, whereas the company factor had a lower value of 0.32. Since the additional variances accounted for by the individual factor (20%) and company factor (10%) are ≥10%, they may be validly distinct from the variance accounted for by the general factor (Dunn & McCray, 2020). The reliability of the general factor is acceptable (Cronbach's alpha = 0.69), that of the employee attitudes is poor (Cronbach's alpha = 0.50) and that for company SQC was marginally acceptable (Cronbach's alpha = 0.66). The poor reliability of the employee attitudes factor may be related to the low ITC score and factor loading of statement A3, which indicates that it is not closely related to the factor/s. Further refinement and improvement of the attitude scale will be beneficial to improve its validity and reliability. Statements A1 and A12 were excluded from the final attitude section. The factor loadings and model path diagram for the final model are shown in Figure 1.

After the exclusion of A1 and A12, $A_{total}$ ranged from 24 to 55 (theoretical range 11–55) with a mean of 45. Very few (0.3%) respondents showed an unfavorable attitude ($A_{total}$ < 50%, scores <28), a larger portion (25%) had a favorable attitude ($A_{total}$ from 50% to 74%, scores from 28 to 41), and most respondents (75%) had a very favorable attitude to SQC ($A_{total}$ ≥ 75%, scores ≥42). This indicates a positive attitude of the respondents in the study towards SQC, although it could also be due to response bias whereby respondents

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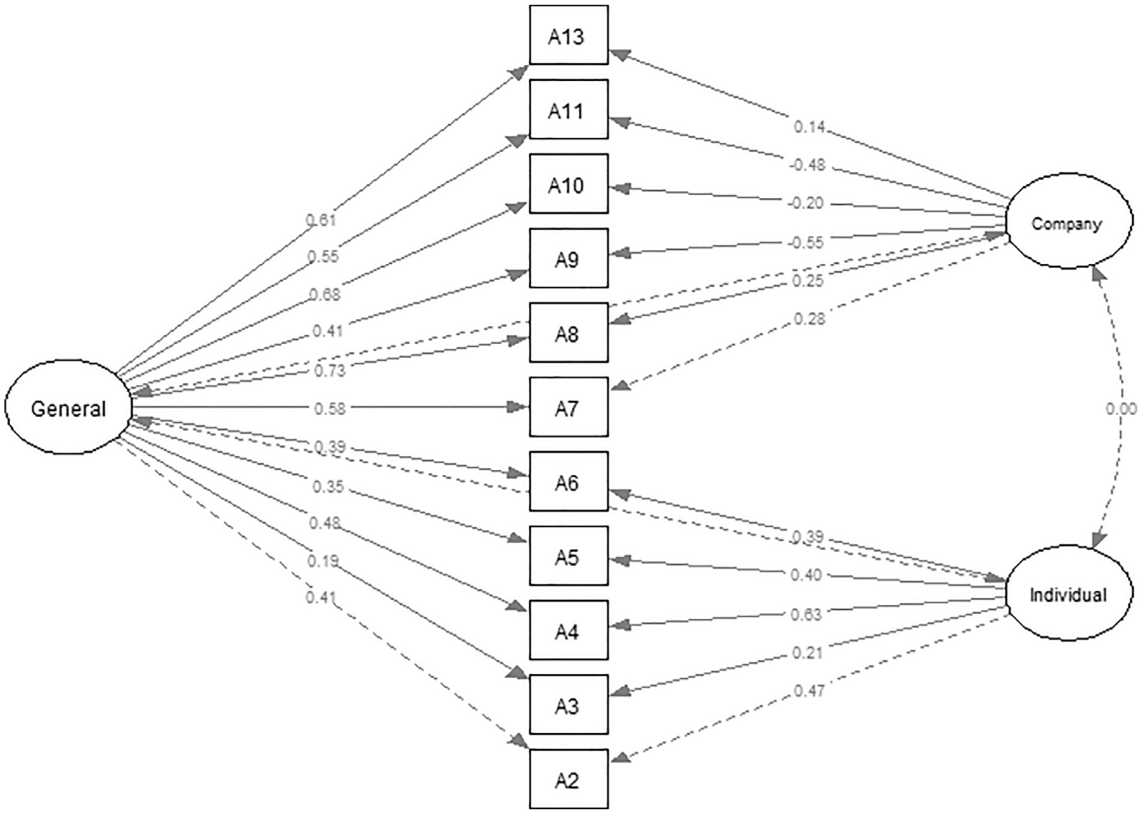


**FIGURE 1** The path diagram of the final model (bifactor, with acceptable model fit) for the attitudes section based on 11 statements. Numbers in vectors indicate the correlation (*r*) between the statements and constructs. Please refer to Table 3 for the statements A2–A13

attempt to present themselves and their company in a positive light (Zanin et al., 2017).

## 3.4 | Validation of the practices section

Good practices within companies as judged by respondents in the study was also generally indicated by a mean above 2 for all the practices questions, except P6 (*What materials/products are evaluated as part of sensory quality control in your company?*). It was surprising and concerning that all respondents reported that their companies only assessed the sensory quality of finished products (mean = 1). This finding supports claims of overreliance on evaluating the quality of finished products by previous authors (Kraggerud, Solem, & Abrahamsen, 2012; Munoz, 2002). Question P6 was excluded from further analysis due to the invariance of responses, but it was retained in the final questionnaire due to its importance to content validity and because it may be relevant for other respondents (Zahiruddin et al., 2018). All other questions contributed well to the assessment of practices as evidenced by the item to total correlations above 0.2 (0.28–0.63) (Table 4).

Prior to CFA, the questions were expected to load on one factor as there was no indication of subdomains in the practices section. Examination of the one-factor solution revealed a poor model fit $\chi^2 = 82.38$ (df = 20, $p < .001$), CFI = 0.93, RMSEA = 0.10 and SRMR = 0.10. Modification indices identified the addition of correlated residuals for P3 ↔ P8 and P9 ↔ P8 to improve model fit. This possibly resulted from similar phrasing and item ordering and was supported by evidence from the inter-item correlation. The addition of both correlated errors resulted in an acceptable model fit, $\chi^2 = 44.60$ (df = 18, $p < .001$), CFI = 0.97, RMSEA = 0.07 and SRMR = 0.07. The modified one factor model was retained. Cronbach's alpha for the one-factor model was 0.74 indicating acceptable internal reliability (Taber, 2018). The nine questions in the original practices section were retained in the final questionnaire (Appendix S2).

The respondents judged that their companies had good sensory practices as evidenced by a $P_{total}$ ranging from 10 to 25 out of a possible 27, with a mean of 22. Very few (2%) respondents reported poor practices ($P_{total} < 50$, scores <14), a larger portion (23%) had good practices ($P_{total}$ from 50% to 74%, scores from 14 to 20), and most responses (75%) had excellent practices ($P_{total} \geq 75\%$, scores ≥21).

There was a statistically significant correlation between the $P_{total}$ and total scores on the statements relating to attitudes to company SQC (A6–A13) ($r = .44$, $p < .001$) and the score for A13 (*My company produces products of consistent sensory quality*) ($r = .27$, $p < .001$). Comparison of the $P_{total}$ scores of respondents working in companies of different size classifications indicated that there was no difference between their SQC practices ($p = .919$). The size of the company was based on the total number of employees as determined by the World Trade Organization (WTO, 2016). This may be an indication that the

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**TABLE 4** The mean, SD, item-total correlation, factor loadings from confirmatory factory analysis (CFA), and Cronbach's α of the practices (P) questions, $n = 287$

| No. | Questions | Mean ± SD | Item-total correlation | Factor loading CFA |
|---|---|---|---|---|
| P1 | How often is sensory evaluation training carried out for company staff? | 2.4 ± 0.7 | 0.413 | 0.706 |
| P2 | When is sensory quality testing carried out for company products? | 2.5 ± 0.8 | 0.280 | 0.396 |
| P3 | How does your company define the target sensory quality of products for quality control purposes? | 2.8 ± 0. 6 | 0.322 | 0.424 |
| P4 | Who manages sensory quality control at your company? | 2.7 ± 0.6 | 0.634 | 0.951 |
| P5 | Who evaluates the products for sensory quality control? | 2.6 ± 0.6 | 0.565 | 0.814 |
| P6 | What materials/products are evaluated as part of sensory quality control in your company? | 1 ± 0 | – | – |
| P7 | Where is product sensory quality testing carried out? | 2.3 ± 0.7 | 0.500 | 0.671 |
| P8 | How are products of unsatisfactory sensory quality handled at your company? | 2.8 ± 0.5 | 0.440 | 0.630 |
| P9 | Does your company check product sensory quality before releasing products to the market? | 2.8 ± 0.5 | 0.503 | 0.716 |
| | Cronbach α | | 0.744 | |

*Note*: See Appendix S2 for the response options.

small size of a company is not necessarily a barrier to the adoption of good sensory practices, which contradicts reports by Carbonell-Barrachina (2007). According to the author, large companies typically incorporate sensory evaluation into the activities of several departments, whereas small companies do not have the qualified personnel or structure required. The $P_{total}$ scores by respondents working at companies that had no customer complaints and product reprocessing was higher ($p < .001$) than those who did. This is an indication of the impact of better sensory quality practices on reducing sensory quality related customer complaints and product reprocessing.

## 3.5 | Implications of the study

In this study, we validated a questionnaire for assessing sensory quality practices in food companies and knowledge and attitude of food industry employees. To our knowledge, this is the first questionnaire that assesses the KAP multi-construct with regards to SQC. Questionnaires are relatively easy and cost effective to administer and the data collected is quantifiable (Launiala, 2009). Hence, small businesses should be able to use the questionnaire through online or paper surveys, but they may need the assistance of a sensory consultant to interpret the results. Furthermore, self-report questionnaires are faster to administer than face-to-face interviews.

This questionnaire was validated using multiple methods to ensure the relevance of the data that will be collected with it. CFA provided evidence of model fit for each section of the questionnaire. Comparison of known groups based on the hypotheses postulated (H1–H6) showed that the responses collected with the questionnaire modeled the expected relationships between KAPs. As expected, respondents with higher knowledge had more positive attitudes towards SQC (H1). Respondents with prior awareness of sensory evaluation (H2), sensory evaluation training (H3) and experience (H4) had significantly higher knowledge than those without. One unanticipated finding was that the larger food companies did not have better sensory quality practices (H5), this may be due to the influence of other factors such as the nature of the product/s manufactured and management's commitment to quality. For instance, companies producing food flavors may have better sensory practices than those producing flour. As expected, there were less customer complaints at companies with better sensory practices (H6).

Overall, the knowledge section showed good discrimination and difficulty indices and covered a wide range of knowledge levels. All questions had acceptable goodness of fit to the one factor model. The sensory evaluation topics covered by the questions will enable the identification of specific gaps in knowledge. For instance, the most difficult questions belonged to the sensory methods or sensometrics area, and more respondents reported a lack of knowledge (I do not know) for the questions related to the senses/physiology compared to other sections. Furthermore, the acceptable fit of the one factor model implies that a summated score can be used to assess knowledge levels of respondents.

Validation of the attitudes section revealed that although all the statements measure a common trait (respondents' attitude) the statements also captured specific variance due to individual disposition to SQC and perception of company SQC. The ITC revealed that A12 did not contribute positively to the assessment of SQC related attitudes, this may be because it attempted to equate two important aspects of product quality (food safety and sensory quality), thus confusing respondents.

The practices questions cover baseline good sensory practices. The practices questions loaded strongly on the one factor model

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indicating good common variance, there was also good correlation between the questions. The study also provides evidence of the over-reliance on finished product testing in SQC. Thus, highlighting the need for alternative approaches to SQC. The total scores for the practices section may be computed as a measure of the compliance of a company to good sensory practices as the one factor model had an acceptable fit. 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 (including observation and document review) rather than self-reporting of SQC practices by the company employees.

Questionnaire development and validation is an ongoing process; hence studies may be carried out to improve the questionnaire, validate it with employees from different countries or specific product category segments and address the limitations of this study. One limitation of this study is the exclusion of food company employees with limited access to the internet as the invitation was sent electronically and the survey was administered online. Future studies should endeavor to also use paper surveys and/or face to face interviewing to ensure adequate representation of employees with limited or no internet access or low levels of literacy or English literacy. There was a high proportion of respondents with favorable attitudes and companies with good practices which may not be a good reflection of real-world conditions. This over representation may have been due to a higher likelihood of respondents with interest in sensory evaluation responding to the survey invite than those with no interest as evidenced by the high proportion of respondents with more than one-year sensory evaluation experience.

## 4 | CONCLUSIONS

Results from IRT analysis, confirmatory factor analyses and known groups comparisons provide evidence of the validity of the knowledge, attitude, and practices sections of the questionnaire. The questionnaire also had good reliability. The study revealed that respondents with sensory evaluation training, experience or sensory job roles had higher sensory evaluation knowledge than their counterparts who did not. Companies with better sensory evaluation practices received fewer customer complaints and the size of the company did not influence sensory quality practices. The questionnaire may be used to identify gaps in respondents' knowledge of specific sensory evaluation topics, making it easier to develop targeted training programs. The revised SQC KAP questionnaire (Appendix S2) consists of 24 knowledge questions, 11 attitude statements and nine practices questions. The final SQC KAP questionnaire can be used to rapidly assess SQC knowledge, attitudes of employee and company sensory quality practices.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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