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# Sensory profiles of artisan goat cheeses as influenced by the cultural context and the type of panel

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**Summary** The research was performed to evaluate influence of the cultural context and the type of panel on sensory profiles of artisan goat cheeses. Two types of sensory panels from the goat cheese-making region (experienced/trained artisan cheese producers vs. goat cheese consumers) and two types of sensory panels from a city area (trained descriptive panellists vs. cheese consumers) were formed. The sensory profiles generated with QDA® and Flash Profile techniques were compared using the hierarchical multiple factor analysis at two levels: type of panel and geographical area. This study demonstrated that sensory panels from the goat cheese-making region used lesser attributes for characterising cheeses. Some discrepancies in sensory profiles were found between the two consumer panels. The two experienced/trained panels were more discriminative and their sensory profiles were similar. Recruiting artisan goat cheese producers for sensory profiling of their own products is a reasonable alternative when training is appropriately conducted.

**Keywords** Artisan goat cheese, consumer panel, cultural context, sensory panel, sensory profile.

## Introduction

Cheese is an important source of proteins for the world population with relevance to the functional dairy industry (Lollo *et al*., 2015; Dantas *et al*., 2016; Pereira *et al*., 2016). The global cheese production is dominated by Europe, followed by USA and Asia (Freitas *et al*., 2016). Particularly, Hispanic cheeses have become popular in the United States due to an increase in the Hispanic population. According to National Agricultural Statistics Service (NASS) (2007, 2016), manufacture of Latin American cheeses increased from 82 million kg in 2006 to 115 million kg in 2015. The different types of cheeses indicated in such reports are mainly those prepared using cow milk. However, other types of milk or mixtures from mammalian species other than cattle, for instance, mare milk supplemented with cow milk, goat milk or sheep milk (Cais-Sokolinska *et al*., 2016), have been used in dairy products. In Mexico, specifically in the high mountains of the State of Veracruz, the traditional artisan type of cheese prepared with goat milk has a potential to enter into international markets.

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Determination of sensory profiles of the cheeses is one of the main tasks required to standardise their sensory quality (Hanaei *et al*., 2015). However, performance of trained sensory panels and consumer panels may vary depending on their cultural background in relation to the region in which the cheeses are manufactured. A comparison of the performance of different panels in different cultural contexts will help to develop a more complete sensory profiling of artisan goat cheeses.

Artisan cheeses are considered part of the cultural context and identity of a region. Their sensory characterisation has been commonly performed by quantitative descriptive analysis (QDA®) where the product is evaluated with a previously trained panel using a set of defined sensory vocabularies to ensure discrimination and repeatability of data (Dos Santos *et al*., 2015). This technique has been used in different studies, for instance, for characterising adulterated cheeses (Aquino *et al*., 2014) and correlating descriptive with hedonic data for probiotic-rich foods and milk candies (Morais *et al*., 2014a; Gaze *et al*., 2015). However, training of panellists is time-consuming and costly. This limitation of QDA® has led to the development of rapid sensory

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techniques, such as flash profile (FP), check all that apply (CATA), napping and ultra-FP (Dairou & Sieffermann, 2002; Cruz *et al*., 2013; Santos *et al*., 2013; Dos Santos *et al*., 2015), that allow the use of consumers as a panel. Recent studies related to artisan goat cheeses have been conducted with this type of panels. However, such panels may be unaware of the origin and cultural context of the artisan cheese (Guerrero *et al*., 2012; Lahne *et al*., 2014); hence, the cultural context and product familiarity of the panel (i.e. daily consumption) that can be useful for sensory characterisation of artisan cheeses may not be fully taken into consideration. Only few studies have considered the cultural context when comparing the sensory profiles of cow milk cheeses (Drake *et al*., 2002, 2009; Gómez-Alvarado *et al*., 2010; Lahne *et al*., 2014). This type of research, in which the experienced artisan cheese producers are included as a sensory panel, has not been conducted on traditional goat cheeses.

According to ISO Standard 8586-2 (1994), these artisan cheese producers may be considered experts in evaluation of this type of product. Hence, a formation of a sensory panel consisting of producers and consumers belonging to the artisan cheese-producing area may be an option for characterisation of traditional goat cheeses.

Therefore, the aims of this research were to determine influences of the cultural context and the type of sensory panel on the sensory profiles of traditional goat cheeses and to determine the appropriate type of panel for sensory characterisation of such products.

## Materials and methods

### Origin and artisanal process of fresh and ripened cheeses

The cheeses were produced in different goat production units (GPUs) affiliated with the nonprofit Goat Species Product System of Veracruz (SIPECAV); these GPUs are located in the municipalities of Coatepec, Coacoatzintla, Perote and Tatatila, situated in the central mountainous region and highlands of the State of Veracruz. The region has a warm-humid climate with temperature, precipitation and altitude ranging from 12–20 °C, 490–1800 mm and 1200–2400 msl, respectively. The cheeses were made with milk from the Alpine and Saanen goat breeds. The cheese-making process was as follows: (i) the milk was pasteurised at 63 °C for 30 min and then cooled to 37 °C; (ii) 30 mL of commercial rennet per 100 L of milk was added and after 45 min the curd was cut and pressed (2 kg force per 1 kg cheese) for 7 h, then moulded in PVC cylinders; (iii) the obtaining curd was immersed in brine (28% salt) and stored at 25 ± 2 °C for 2 days to obtain fresh cheeses. Ripened cheeses were obtained by inoculating the fresh cheese with *Penicillium candidum* which were then stored in cellars at 16 ± 2 °C and 80–85% relative humidity for 7 weeks. The cheeses were made in the rainy season, and for this research, two kg of each cheese, per GPU, was obtained. The origin, both location and GPU, where the artisan goat cheeses were made is shown in Table 1.

### Sample preparation for the sensory analysis

The cheeses were kept at 25 ± 2 °C for 1 h and subsequently cut into pieces with 1.5 cm diameter and 3 cm thickness. Each panellist was served with 20 g of cheese. All cheese samples were coded with three randomly selected digits. The sensory analysis of the cheeses was performed separately, starting with the fresh cheeses, and the ripened cheeses were evaluated 7 weeks later.

### Make-up of the sensory descriptive panels

A total of forty-three panellists participated in the sensory descriptive analysis. Two types of panels from two geographical locations were formed: (i) artisan cheese producers (experienced, PROD, $n = 7$) vs. product users/consumers (COCOAT, $n = 12$) from the goat cheese-making area, Coatepec city, Veracruz, México, and (ii) trained (PVER, $n = 8$) vs. product users/consumers (COVER, $n = 16$) from Veracruz City.

The PROD panel (seven men, aged 38–54 years) who had over 3 years of experience in the manufacture of artisan goat cheeses was trained at the beginning of the study. The PVER trained panel (five women and three men, aged 25–32 years) had over 1 year of experience in sensory characterisation of different artisan and commercial cheeses. The selection and number of trained/experienced judges in this research was consistent with the ISO Standard 8586-1 (1993), the ISO Standard 11035 (1994) and Waehrens *et al*. (2016). PVER and PROD panels were developed in three stages. In stage 1, a survey was performed to determine availability, motivation and no aversion of the panellists towards the goat cheese (ISO Standard

**Table 1** Identification of fresh and ripened cheeses

| Fresh cheese | | Ripened cheese | |
|---|---|---|---|
| GPU | Municipality and codification | GPU | Municipality and codification |
| Dónelo | Coatepec | Dónelo | Coatepec-1 |
| Altalpas | Coacoatzintla | Luis | Coatepec-2 |
| Enríquez | Perote | Enríquez | Perote |
| Rincón del Rio Frío | Tatatila | Rincón del Rio Frío | Tatatila |

GPU, goat production unit; Coatepec-1: GPU located in the community of Pacho Viejo, Coatepec, Veracruz; Coatepec-2: GPU located in the municipality of Coatepec City, Veracruz.

8586–1, 1993). In stage 2, screening tests such as basic taste (sweet, sour, bitter and salty) and aroma recognition (ISO Standard 5496, 2005) tests, discriminative triangle (ISO Standard 4120, 2004) and duo-trio (ISO Standard 10399, 2004) tests and texture description test (ISO Standard 8586–1, 1993) were performed. In stage 3, test results were evaluated using the sequential analysis technique (ISO Standard 16820, 2004).

For the COCOAT consumer (twelve women, aged 25–50 years) panel, they were selected due to frequent consumption of artisan goat cheeses according to an applied survey. For the COVER consumer (seven men and eleven women, aged 24–39 years) panel, they were selected based on regular consumption of cow milk cheese commonly available at the local market of the municipality of Veracruz.

### Sensory descriptive analysis procedures

The PVER and PROD panels developed the sensory profile of the artisan goat cheeses using the quantitative descriptive analysis (QDA)® method according to ISO 11035 (1994) with slight modifications for a scale used and how to select and define sensory attributes. A 9-cm scale was used instead of a 15-cm scale as it is relatively more sensitive than others according to Stone & Sidel (2004). According to the ISO standard 11035, it is necessary to conduct several sessions in order to select and define sensory vocabulary. However, due to the time constraint of the manufacturers, consensus among the panellists was used, which was achieved in two sessions.

During the first two sessions, a list of sensory vocabulary (Table 2) was first determined by consensus (Hernández-Morales *et al*., 2010); in sessions 3–8, the cheese samples were evaluated to determine their sensory profiles. The cheese samples were served in a sequential monadic manner, following the optimal Latin square experimental design (MacFie *et al*., 1989; Périnel & Pagès, 2004). Each session lasted 30–50 min. References for the study included commercial fresh and ripened goat cheeses from the local supermarket in Veracruz, México, and those suggested by Rainey (1986). The use of commercial references allowed us to reduce costs and ensure availability.

The COCOAT and COVER product user/consumer panels used the FP technique for generating the sensory profiles as described by Dairou & Sieffermann (2002). In the first session, each consumer created a list of attributes covering the sensory dimension of sight, touch, smell and taste (including aftertaste). In the second session, the lists were compared and finalised, and in the third session, the cheeses were evaluated. The samples were served to these panels using the multiple simultaneous methods (Mazzucchelli & Guinard, 1999). Each session lasted 30–50 min.

All PVER, PROD, COCOAT and COVER panels evaluated cheese samples using a continuous 9-cm line scale with label anchors from weak to strong intensity. White bread and water were provided as palate cleansers between samples (Hayaloglu *et al*., 2013). Sensory profiles by the PVER and COVER panels were made at the Colegio de Postgraduados Campus Veracruz, located in the municipality of Veracruz Ignacio de la

**Table 2** Sensory vocabularies of fresh and ripened cheeses generated by the PVER and PROD trained panels using the QDA® technique

| Fresh cheese | | Ripened cheese | |
|---|---|---|---|
| **Attributes (PVER panel)** | **Attributes (PROD panel)** | **Attributes (PVER panel)** | **Attributes (PROD panel)** |
| White colour (WHIT-C) | White colour (WHIT-C) | Yellow colour (YELL-C) | Cream colour (CREA-C) |
| Porous surface (PORS) | Without holes (W/EYES) | Hard to touch (HARD-T) | Opaque (OPAQ) |
| Presence of whey (WHEY-P) | Presence of wetness (WETN-P) | Gritty to touch (GRIT-T) | Hard to touch (HARD-T) |
| Firmness to touch (FIRM-T) | Firmness to touch (FIRM-T) | Goat smell (GOAT-S) | Brittle (BRIT) |
| Creamy to touch (CREA-T) | Gritty to touch (GRIT-T) | Milk smell (MILK-S) | Dry to touch (DRY-T) |
| Citrus smell (CITR-S) | Sticky to touch (STIC-T) | Fermented smell (FERM-S) | Fermented smell (FERM-S) |
| Whey smell (WHEY-S) | Greasy to touch (GREA-T) | Citrus smell (CITR-S) | Ripened cheese smell (MATU-S) |
| Salty (SALT) | Acid smell (ACID-S) | Fruity smell (FRUI-S) | Salty (SALT) |
| Acid (ACID) | Milk smell (MILK-S) | Wet wood smell (WOOD-S) | Acid (ACID) |
| Firmness in the mouth (FIRM-M) | Bitter (BITT) | Salty (SALT) | Bitter (BITT) |
| Goat aroma (GOAT-A) | Acid (ACID) | Acid (ACID) | Sour (SOUR) |
| Milk aroma (MILK-A) | Fermented aroma (FERM-A) | Gritty in the mouth (GRIT-M) | Fungal aroma (FUNG-A) |
| Citrus aroma (CITR-A) | Milk aroma (MILK-A) | Goat aroma (GOAT-A) | Crumble in the mouth (CRUM-M) |
| Whey aftertaste (WHEY-AF) | Bitter aftertaste (BITT-AF) | Fermented aroma (FERM-A) | Ripened cheese aftertaste (MATU-AF) |
| Milk aftertaste (MILK-AF) | Fermented aftertaste (FERM-AF) | Fruity aroma (FRUI-A) | Bitter aftertaste (BITT-AF) |
| Greasy aftertaste (GREA-AF) | | Fungal aroma (FUNG-A) | Fungal aftertaste (FUNG-AF) |
| Goat aftertaste (GOAT-AF) | | Dry aftertaste (DRY-AF) | |

PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese; C, colour; A, retronasal aroma; T, texture by touching; M, mechanical/masticated in the mouth; S, smell via a nasal passage; Af, aftertaste.

Llave, while the profiles by the PROD and COCOAT panels were made at GPUs located in the community of Pacho Viejo belonging to the municipality of Coatepec, Veracruz. Duplicate measurements were made by all panels for all cheese samples.

### Statistical analysis

Sensory spaces generated with the QDA® and FP data were performed using principal component analysis (PCA) and generalised Procrustes analysis (GPA), respectively (Dairou & Sieffermann, 2002). PCA for the PVER panel was conducted with matrices of 4 fresh cheeses × 17 attributes and 4 ripened cheeses × 17 attributes, while matrices of 4 fresh cheeses × 15 attributes and 4 ripened cheeses × 16 attributes were used for the PROD panel. GPA was conducted for the COVER consumer panel data with matrices of 4 fresh cheeses × 50 attributes and 4 ripened cheeses × 35 attributes, while matrices of 4 fresh cheeses × 34 attributes and 4 ripened cheeses × 32 attributes were used for the COCOAT consumer panel.

Multidimensional discrimination per panel was evaluated by confidence ellipses per product, which contains 95% of the representations of a product obtained from the generation of virtual panels of judges by randomly resampling 500 times from the actual panels (Cadoret & Husson, 2013).

The approximation of the sensory profiles was performed using the hierarchical multiple factor analysis (HMFA) technique at two levels [level 1 = comparison of the sensory profiles among panels (PROD, PVER, COCOAT and COVER) and level 2 = comparison of sensory profiles between areas (Coatepec and Verecruz)] (Lê-Dien & Pagès, 2003). HMFA was conducted with matrices of 4 fresh cheeses × 116 attributes and 4 ripened cheeses × 100 attributes. The Rv coefficient was applied at the two HMFA levels to determine the correlation between the generated sensory profiles (Josse *et al.*, 2008).

The PCA and GPA tests were conducted with the XLSTAT software, version 2009 (Addinsoft, New York, NY, USA). Confidence ellipses, HMFA and the Rv coefficient were performed with SensoMineR and FactoMineR packages implemented in programming language R version 2.15.3, 2013 (Lê-Dien & Husson, 2008).

## Results

### Sensory vocabulary and comparisons of cheese characterisation by PROD and PVER panels

The panels with experience either in cheese production (PROD) or in sensory descriptive training on cheese products (PVER) generated a similar number of sensory vocabularies, fifteen to seventeen for fresh cheeses and sixteen to seventeen for ripened cheeses (Table 2). Similarities in the generated sensory vocabularies were observed between PROD and PVER. For example, for fresh cheeses, both PVER and PROD panels used the same terms such as white colour (WHIT-C), firmness to touch 'FIRM-T' and acid (ACID), while for ripened cheeses, hard to touch (HARD-T), fermented smell (FERM-S), salty (SALT), acid (ACID) and fungal aroma (FUNG-A) were used. For fresh cheeses, some different vocabularies but having similar meanings included creamy to touch (CREA-T) vs. greasy to touch (GREA-T), both of which were referred to the lipid content of the cheeses, and porous surface (PORS) vs. without holes (W/EYES), both were referred to surface porosity, whereas for ripened cheeses, yellow colour (YELL-C) vs. cream colour (CREA-C) and gritty in the mouth (GRIT-M) vs. crumble in the mouth (CRUM-M) were used (Table 2).

The PVER panel generated more diverse vocabularies, especially for aroma and retronasal terms, than the PROD panel (Table 2). Some differences in the vocabularies generated by the two panels were observed. For fresh cheeses, citrus smell (CITR-S), citrus aroma (CITR-A), goat aroma (GOAT-A) and goat aftertaste (GOAT-AF) were generated by the PVER, but not PROD panel, while fermented aroma (FERM-A) and fermented aftertaste (FERM-AF) were generated by PROD only. Likewise for the ripened cheeses, goat smell (GOAT-S), goat aroma (GOAT-A), citrus smell (CITR-S), fruity smell (FRUI-S), fruity aroma (FRUI-A) and wet wood smell (WOOD-S) were generated by the PVER, but not PROD panel, while ripened cheese smell (MATU-S) and ripened cheese aftertaste (MATU-AF) were generated by PROD only (Table 2).

For fresh cheeses, the percentages of inertia (variance distribution) in the first two principal components were 91.96% and 88.28% for the PVER (Fig. 1a) and PROD (Fig. 1b) panels, respectively. Based on the PCA plots, it could be visualised that both panels similarly grouped the Coatepec and Coacoatzintla cheeses in contrast to the Perote and Tatatila cheeses. Characterisation of the Coacoatzintla (WHIT-C), Coatepec (ACID) and Perote (FIRM-M and FIRM-T by PVER vs. FIRM-T and GRIT-T by PROD) cheeses was similar between the two panels. However, the Tatatila cheese was possibly perceived as GOAT-A, GREA-AF and GOAT-AF by the PVER panel, while GREA-T, FERM-A and FERM-AF by the PROD panel.

For ripened cheeses, the percentages of inertia (variance distribution) in the first two principal components were 96.36% and 88.79% for the PVER (Fig. 2a) and PROD (Fig. 2b) panels, respectively. Based on the PCA plots, it could be visualised that both panels similarly grouped the ripened Perote and Coatepec-2 cheeses in contrast to the Coatepec-1 and Tatatila

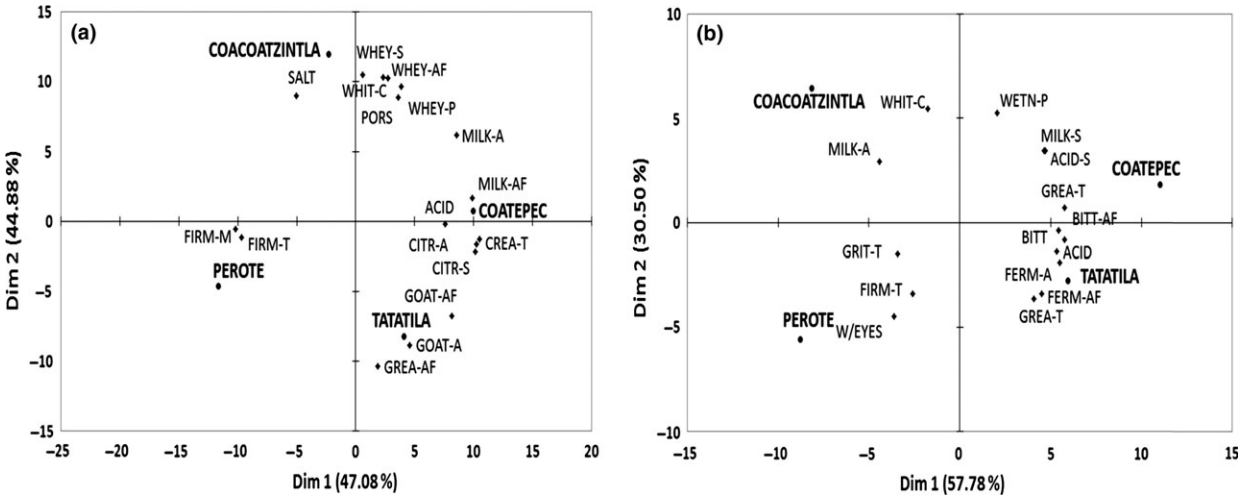


**Figure 1** Graphical representation of sensory profiles of fresh cheeses developed by the PVER (a) and PROD (b) trained panels using principal component analysis. PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese; C, colour; A, retronasal aroma; T, texture by touching; M, mechanical/masticated in the mouth; S, smell via a nasal passage; Af, aftertaste; (♦) = sensory attributes; (●) = artisan cheeses.

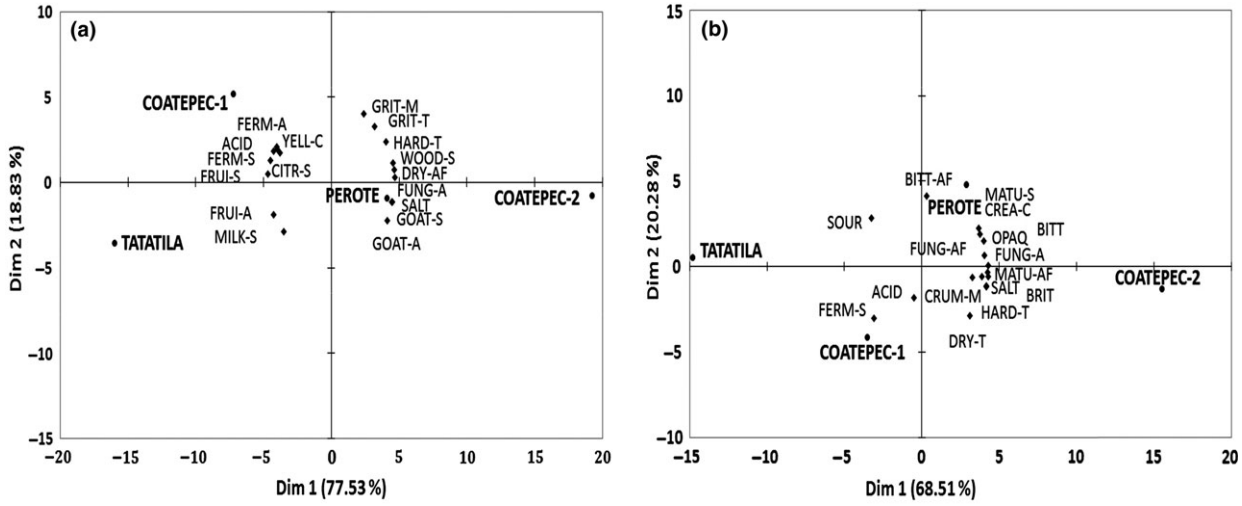


**Figure 2** Graphical representation of sensory profiles of ripened cheeses developed by the PVER (a) and PROD (b) trained panels using principal component analysis. PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese; C, colour; A, retronasal aroma; T, texture by touching; M, mechanical/masticated in the mouth; S, smell via a nasal passage; Af, aftertaste; (♦) = sensory attributes; (●) = artisan cheeses.

cheeses. Both panels associated FERM-S and ACID attributes with the Coatepec-1 cheese, while FUNG-A and SALT attributes were perceived mostly in the Perote and Tatatila cheeses. Some discrepancies in sensory characterisation were also observed (Fig. 2a and b). For example, the Coatepec-2 and Perote cheeses were characterised by GRIT-T, GRIT-M, HARD-T, WOOD-S, GOAT-S, SALT, GOAT-A and DRY-AF according to the PVER panel, while the PROD panel perceived these cheeses as CREAM-C, OPAQ, CRUM-M, HARD-T, DRY-T, BRIT, MATU-S, BITT, SALTY, BITT-AF, FUNG-AF and MATU-AF. For the Coatepec-1 cheese, the PVER panel perceived it as YELL-C, FRUIT-S, CITR-S and FERM-A, while the PROD panel perceived it as ACID and FERM-S. The Tatatila cheese was characterised as MILK-S and FRUIT-A by the PVER panel, while as SOUR by the PROD panel (Fig. 2a and b).

### Sensory vocabulary and comparisons of cheese characterisation by the product users/consumer panels

For fresh cheeses, the sensory vocabularies generated by the COVER and COCOAT consumer panels consisted of fifty attributes (thirteen appearance, one touch, five smell, twenty-eight taste and three aftertaste) and thirty-four attributes (twelve appearance, seven touch, four smell, six taste and five aftertaste), respectively. Figure 3a and c shows similarities in the percentages of inertia (variance distribution) between the COVER (88.07%) and COCOAT (89.64%) panels, respectively. The distribution of fresh cheeses on the sensory plane indicated that both panels similarly grouped the Coatepec and Tatatila cheeses in contrast to the Perote and Coacoatzintla cheeses. The COVER panel characterised Coatepec fresh cheese with appearance (GREASY, WET and SHINY), mechanical (CREAMY-T, CREAMY-M, SOFT-M and GREASY-T) and ACID attributes (Fig. 3b). The COCOAT panel characterised the fresh Coatepec cheese as WHITE-C and CREAMY-AP (Fig. 3d). The fresh Tatatila cheese was perceived by the COVER panel as YELLOW-C, ELASTIC, SWEET-S and SALTY, while the COCOAT panel perceived it as CREAMY-A, YOGURT-S, ACID, AGED-AF and ACID-AF. The COVER panel characterised the Coacoatzintla cheese as WHITE-C, CRUMBLY-T, HARD-M, SALTY and STABLE-A and the Perote cheese as HARD, SOUR, SALTY and SALTY-AF, while the COCOAT panel perceived the Coacoatzintla and Perote cheeses as WHEY-S, MILK-S and CREAMY-T.

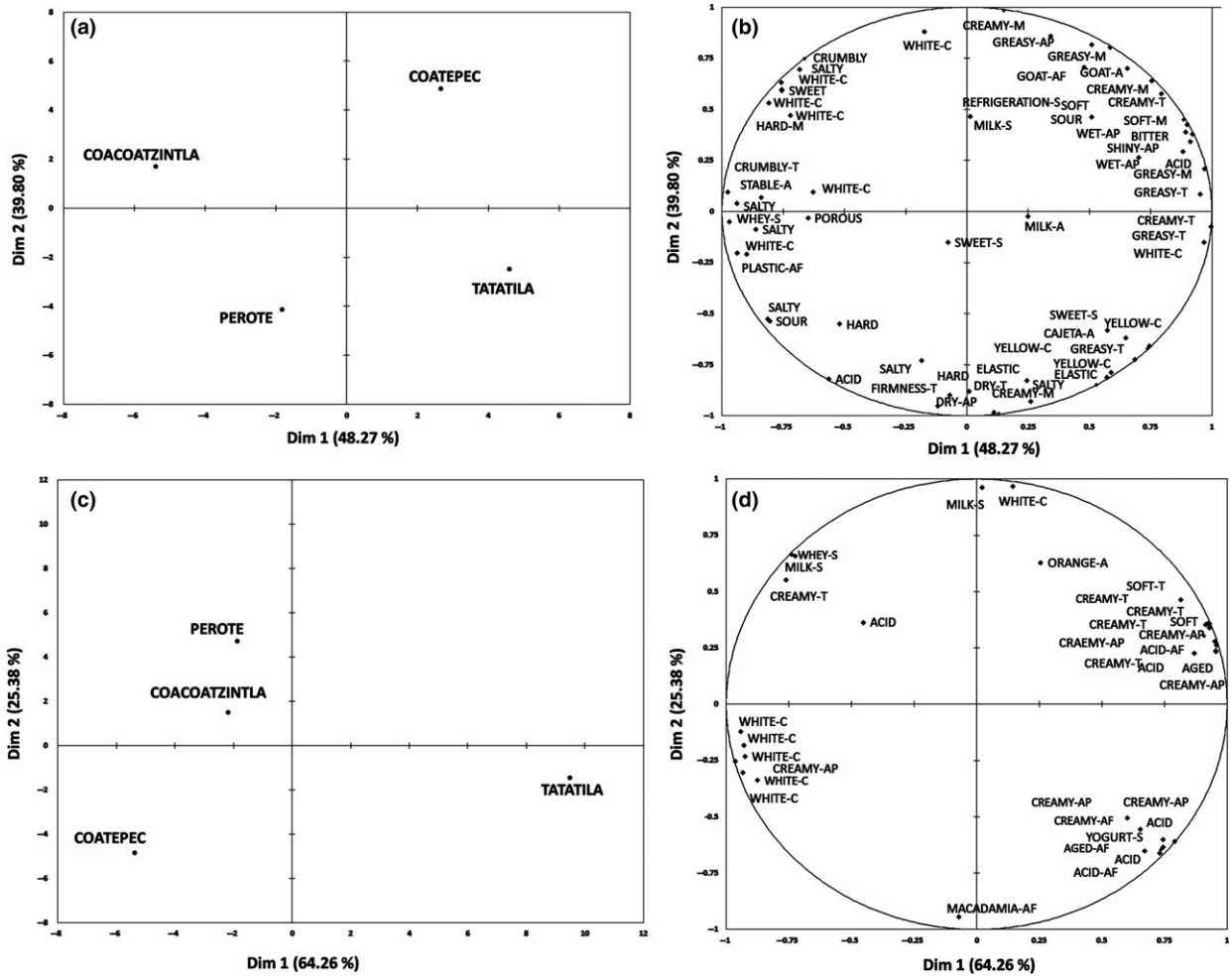


**Figure 3** Graphical representation of sensory profiles of fresh cheeses developed by the COVER (a, b) and COCOAT (c, d) consumer panels using generalised Procrustes analysis. AP, appearance; A, retronasal aroma; C, colour; T, texture by touching; M, mechanical/masticated in the mouth; S, smell via a nasal passage; AF, aftertaste; (♦) = sensory attributes; (●) = artisan cheeses; COVER, consumers selected based on regular consumption of cow milk cheese; COCOAT, consumers selected based on frequent consumption of artisan goat cheeses.

For ripened cheeses, the COVER panel used a total of thirty-five sensory attributes (six appearance, eight touch, seven smell, eleven taste and three aftertaste), whereas the COCOAT panel used only thirty-two sensory attributes (eight appearance, six touch, five smell and thirteen taste). The percentages of inertia (variance distribution) in the first two principal components were 91.18% for the COVER panel (Fig. 4a) and 86.56% for the COCOAT panel (Fig. 4c). The representation of the ripened cheeses in the sensory space was similar between the two panels; that is, the Perote and Tatatila cheeses were grouped in contrast to the Coatepec-2 and Coatepec-1 cheeses (Fig. 4a and c). The COVER panel associated WHITE-C, BRITTLE, GOAT'S MILK-S, ACID and SALTY attributes with Coatepec-2 cheese (Fig. 4a and b), while the COCOAT panel characterised this cheese as DRY, HARD-T, GOAT'S MILK-S and GOAT'S MILK-A (Fig. 4d). The COVER panel perceived Coatepec-1 cheese as YELLOW-C, CREAMY-T, SWEET-S and BITTER, while the COCOAT panel characterised it as YELLOW-C, CREAM-C, ORANGE-A, AGED and BITTERSWEET. The Tatatila cheese was characterised by the COVER panel as PRESENCE OF FAT, FERMENTED-S and SOFT-M (Fig. 4b), whereas by the COCOAT panel as YELLOW-C, CREAMY, SOFT-M and ACID (Fig. 4d). The

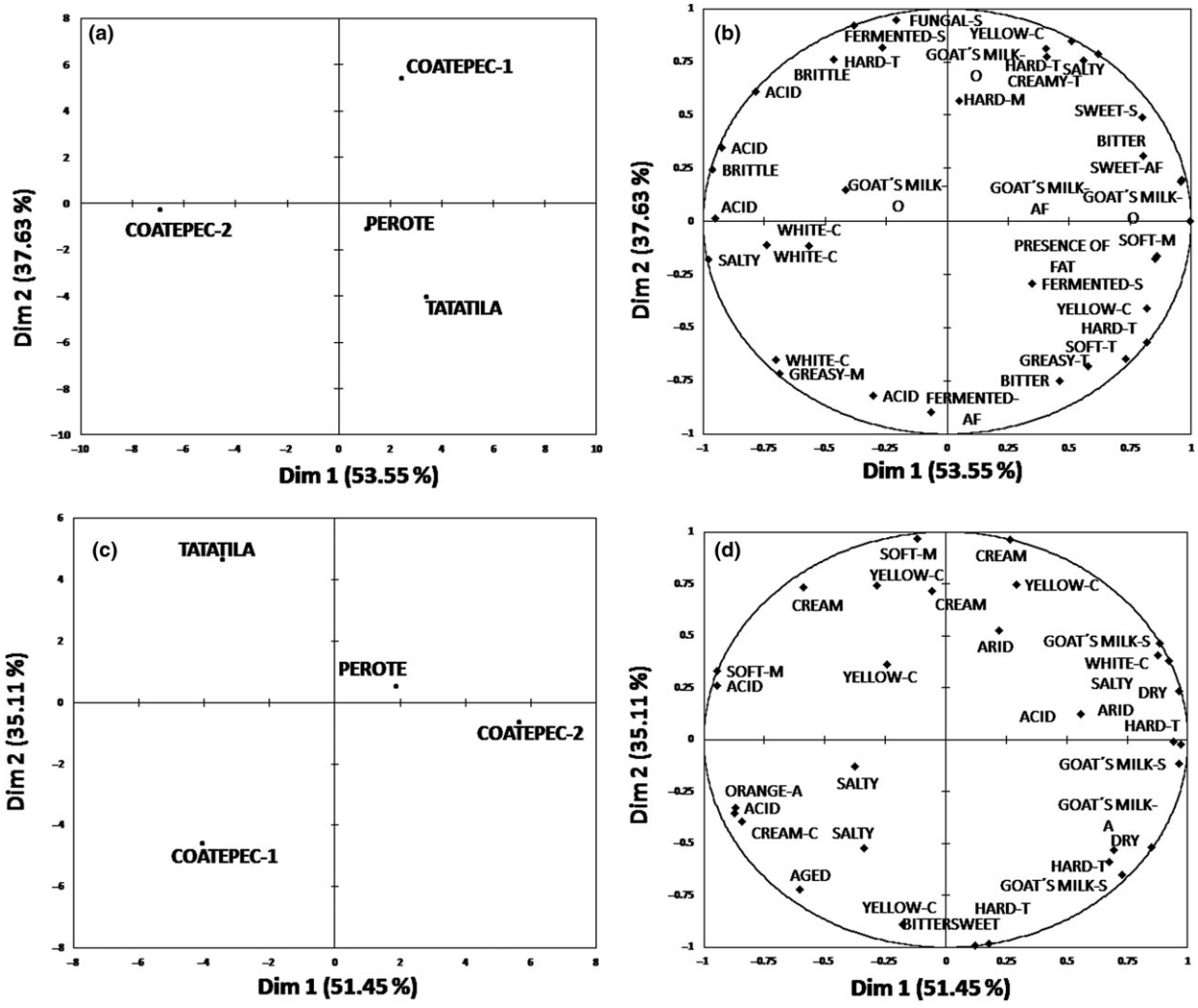


**Figure 4** Graphical representation of sensory profiles of ripened cheeses developed by consumer panels COVER (a, b) and COCOAT (c, d) using generalised Procrustes analysis. AP, appearance; A, retronasal aroma; C, colour; T, texture by touching; M, mechanical/masticated in the mouth; S, smell via a nasal passage; AF, aftertaste; (♦) = sensory attributes; (●) = artisan cheeses; COVER, consumers selected based on regular consumption of cow milk cheese; COCOAT, consumers selected based on frequent consumption of artisan goat cheeses.

Perote cheese showed no predominance in any sensory attribute, and therefore, its representation on the sensory plane was located near the centre (Fig. 4c and d).

### Multidimensional discrimination by sensory panels

According to the confidence ellipses, it was found that all panels could discriminate among the fresh cheeses (Fig. 5a–d). The ripened cheeses could only be differentiated by the PVER and PROD panels (Fig. 6a and b); moreover, the COVER panel considered the Perote and Tatatila cheeses to be similar and the COCOAT panel was unable to differentiate among the Perote, Tatatila and Coatepec-2 cheeses (Fig. 6c and d). The confidence ellipses generated with the results of the PVER and PROD panels were somewhat similar in size, as also observed for the ellipses generated with the results of the COVER and COCOAT panels.

### Comparisons and statistical approximation of sensory profiles

The partial representations (Fig. 7a and b) showed that the sensory profiles of the fresh cheeses, generated by each sensory panel, exhibited similarities; the similar effect was observed in the sensory profiles of the ripened Coatepec-1, Coatepec-2 and Tatatila cheeses (Fig. 7b). The first HMFA level (Fig. 8a) shows greater proximities between the PROD, PVER and COVER panels; the correlation values confirmed this effect ($Rv_{PVER\text{-}PROD} = 0.95$, $Rv_{PROD\text{-}COVER} = 0.94$,

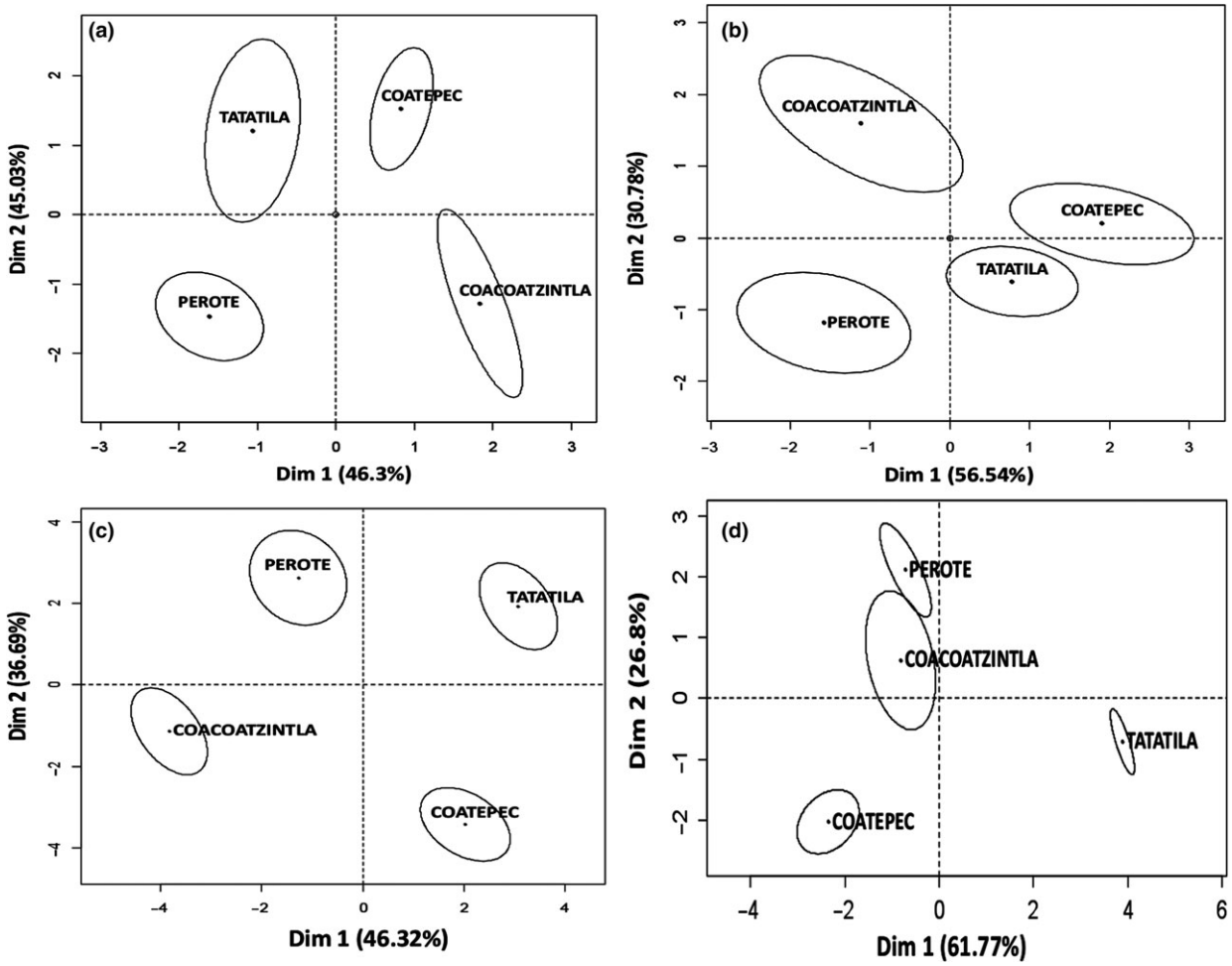


**Figure 5** Confidence ellipses of fresh cheeses for each sensory panel: (a) PVER, b) PROD, (c) COVER and (d) COCOAT. Confidence ellipses were generated from 500 resamplings with a confidence level of 95%. Ellipse overlapping indicates no significant differences among cheeses. COVER, consumers selected based on regular consumption of cow milk cheese; COCOAT, consumers selected based on frequent consumption of artisan goat cheeses; PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese.

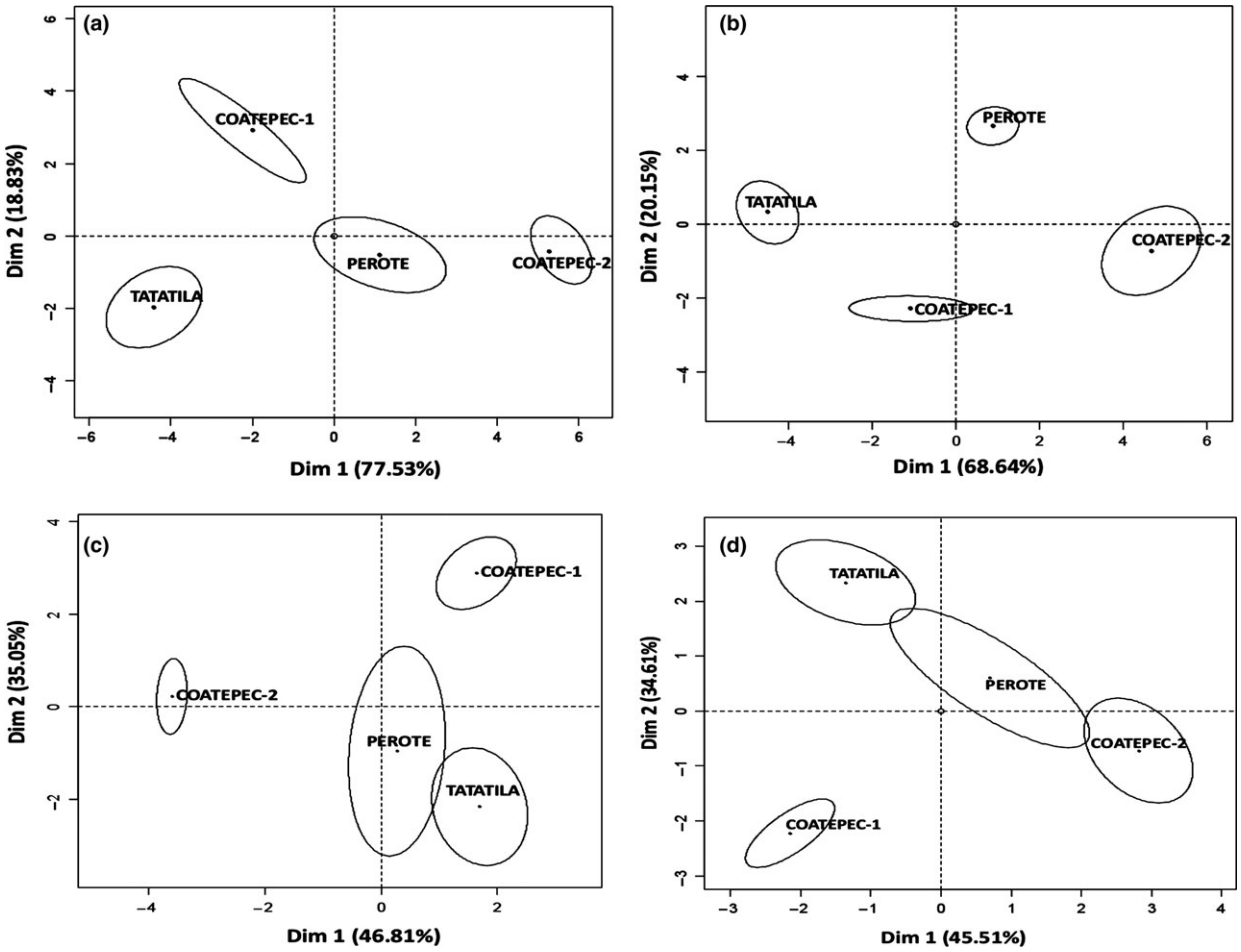


**Figure 6** Confidence ellipses of ripened cheese for each sensory panel: (a) PVER, (b) PROD, (c) COVER and (d) COCOAT. Confidence ellipses were generated from 500 resamplings with a confidence level of 95%. Ellipse overlapping indicates no significant differences among cheeses. COVER, consumers selected based on regular consumption of cow milk cheese; COCOAT, consumers selected based on frequent consumption of artisan goat cheeses; PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese.

$Rv_{PVER\text{-}COVER} = 0.95$) with the COCOAT panel disagreeing with the rest of the panels in the evaluation of the fresh cheese ($Rv_{PROD\text{-}COCOAT} = 0.58$, $Rv_{COCOAT\text{-}PVER} = 0.63$ and $RvCOVER\text{-}COCOAT = 0.78$). In the evaluation of the ripened cheese (Fig. 8b), the first HMFA level showed short distances between the experienced producers/trained panels ($Rv_{PVER\text{-}PROD} = 0.96$) and between the consumer panels ($Rv_{COVER\text{-}COCOAT} = 0.94$). However, acceptable correlations (above 0.75) were obtained between the different panels ($Rv_{PROD\text{-}COCOAT} = 0.87$, $Rv_{COCOAT\ -PVER} = 0.89$, $Rv_{PROD\text{-}COVER} = 0.90$, $Rv_{PVER\text{-}COVER} = 0.88$). Figure 8a and b also demonstrates that the sensory profiles generated in Veracruz and Coatepec (the second HMFA level) showed high concordance in the characterisation of the fresh ($Rv_{VERACRUZ\text{-}COATEPEC} = 0.89$) and ripened ($Rv_{VERACRUZ\text{-}COATEPEC} = 0.99$) cheeses.

## Discussion

### Discrepancies in sensory characterisation of artisan goat cheeses by different sensory panels

The high percentages (>70%) of inertia (variance distribution) of the first two principal components/dimensions (Figs 1–4) allowed reasonable comparisons of the sensory profiles of the artisan cheeses; in other words, this demonstrated a good representation of the data (Phu *et al*., 2010). According to data from Table 2 and Figs 3 and 4, the largest discrepancies among panels were found in the sensory attributes related to taste and aftertaste. In the case of the PVER and PROD panels, differences in some sensory attributes generated by the panels were likely due to experience in goat cheese production activities. Between COCOAT and COVER

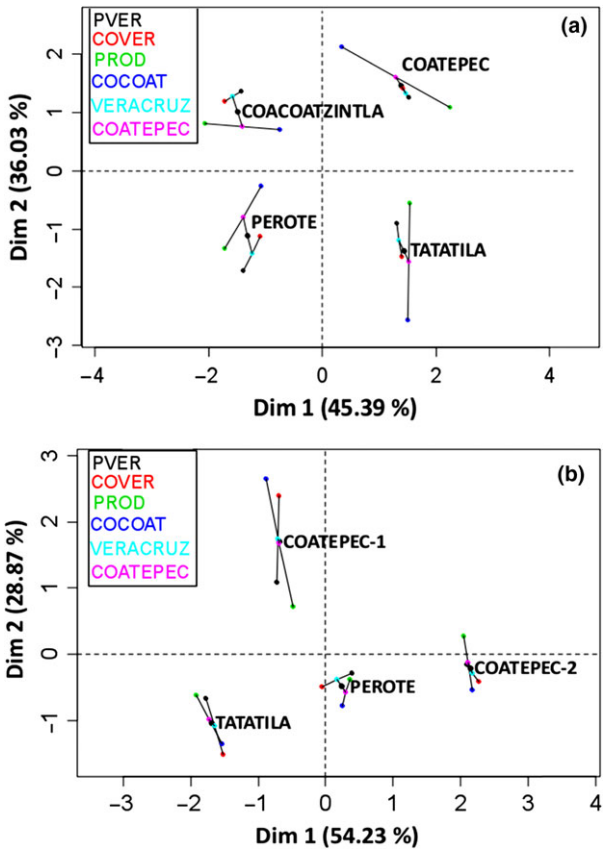


**Figure 7** First two principal components from HMFA: fresh (a) and ripened (b) cheese positioning generated with sensory profiles of each type of panel and geographical area. Each cheese was characterised by four sensory profiles (one profile per panel) and by two sensory profiles generated in the two geographical areas (Veracruz and Coatepec); COVER, consumers selected based on regular consumption of cow milk cheese; COCOAT, consumers selected based on frequent consumption of artisan goat cheeses; PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese; HMFA, hierarchical multiple factor analysis.

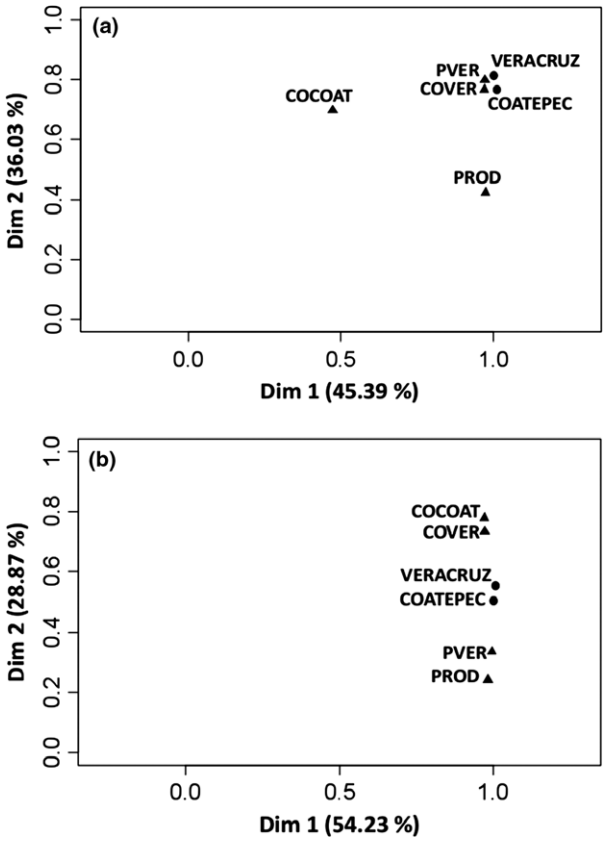


**Figure 8** Representation of the two hierarchical multiple factor analysis (HMFA) levels for fresh cheeses (a) and ripened cheeses (b). (▲) = the first level of the HMFA (trained panels and consumers); (●) = the second level of the HMFA (geographical origin of the panels); two geographical areas (Veracruz and Coatepec); COVER, consumers selected based on regular consumption of cow milk cheese; COCOAT, consumers selected based on frequent consumption of artisan goat cheeses; PVER = a trained sensory descriptive panel; PROD = a panel consisting of experienced artisan cheese producers of the goat cheese.

consumer panels, the cultural aspect may have influenced, however, to a lesser extent, the appearance, touch and smell attributes; this result is consistent with that reported by Phu *et al.* (2010), who observed that the cultural aspect had less influence on textural parameters in the evaluation of dairy products by French vs. Vietnamese consumers. In this study, the panels from the artisan cheese production area (PROD and COCOAT) used fewer sensory attributes to characterise the goat cheeses. This trend was also observed by Blancher *et al.* (2007) and Gómez-Alvarado *et al.* (2010), who found that the panels from the area where the product was made used fewer attributes to characterise artisan jellies and cheeses. This effect is generated by familiarity with the product. According to Sester *et al.* (2013), such effect is derived from autobiographical consumption events and the representation of the product in the consumer's semantic memory. Guerrero *et al.* (2012) argued that this familiarity is generated by the strong emotional, cultural or social ties of the people living in the area, region or country where the product is manufactured.

A larger number of sensory attribute vocabularies generated by the PVER and COVER panels were due to the fact that they used more than one word to describe the same perception. This cognitive process is common when people do not know a product and tend to associate it with a similar one, which was observed in our study. Likewise, the effect of the context of the sensory experience was observed for jellies (Blancher *et al.*, 2007) and cheeses (Lahne *et al.*, 2014). In this sense, the

type of cheese consumed could have an impact on the results, as the PVER and COVER panels more often consumed cow milk cheeses, while the PROD and COCOAT panels regularly consumed goat and cow milk cheeses, among others. Therefore, consumption of different types of cheeses may contribute to the enrichment of sensory vocabularies and the specification of each type of cheese.

When comparing between fresh and ripened cheeses (Figs 5 and 6), the PVER and PROD panels showed better discrimination ability than the COCOAT and COVER consumer panels, especially for the ripened cheeses. This was also observed by Worch *et al.* (2010). Furthermore, Drake *et al.* (2002) mentioned that difficulty in evaluating complex foods, such as ripened cheeses, can contribute to the discrepancy in results between panels. Even though there are some similarities in the sensory vocabularies between consumer and trained panels, differences in the perceived intensity could affect the results (Drake *et al.*, 2002; Blancher *et al.*, 2007). It is also possible that producers and trained panellists used different terms for the same sensation. In fact, Zannoni (1997) indicated that each culture develops its own language and vocabulary. In this study, there were four panels using different techniques making it more difficult to reach a consensus. Future studies may be focused on unifying criteria and lexicon for sensory profiling among trained and consumer panels. Additionally, the sensory vocabularies used by the consumer panel may be oriented towards preference or rejection, not quality characterisation. For this purpose, it is possible to conduct additional research in order to explore the use of hedonic tests with consumers (Morais *et al.*, 2014b) and their relation with sensory attributes of the product by constructing external preference maps (Drake *et al.*, 2009) or ideal profile mapping (Worch, 2013). Other techniques such as time-intensity (TI) methods and temporal dominance of sensations (TDS) (Rodrigues *et al.*, 2014) can be useful in analysing the behaviour of sensory attributes of artisan goat cheeses with time.

## Conclusions

This study demonstrated differences in sensory characterisation of fresh and ripened artisan goat cheeses among sensory panels. The cultural context (two geographical areas, one with more frequent consumption of goat milk cheese vs. more cow milk cheese) inserted more effects on generated sensory profiles of artisan cheeses, especially ripened cheeses, than the type of sensory panel (experienced/trained vs. consumers). The ripened cheeses could only be differentiated by experienced/trained (PROD and PVER) panels, and PVER and COVER panels, who more often consumed cow milk cheeses, used more sensory descriptors to characterise the artisan goat cheeses. Therefore, various types of sensory panels as influenced by cultural context can provide valuable information in terms of diversity of vocabulary (consumer panels) and discrimination (trained panels) for sensory profiling of artisan goat cheeses, allowing a better understanding of manufacturer and consumer requirements. In this perspective, using actual manufacturers of artisan goat cheese products may help to identify and measure sensory characteristics that define the product as traditionally manufactured in a specific region in order to maintain their quality for different markets.

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## Conflict of interest

The authors declare no conflict of interest.

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