CONNECTING FLAVORS IN SOCIAL MEDIA: A CROSS CULTURAL STUDY WITH BEER PAIRING

Araceli Arellano-Covarrubias[a,*], Carlos Gómez-Corona[b,*], Paula Varela[c], Héctor B. Escalona-Buendía[a,*]

[a] *Sensory and Consumer Laboratory, Biotechnology Department, Universidad Autónoma Metropolitana, Av. San Rafael Atlixco No. 186, 09340 Mexico City, Mexico*
[b] *XOC editorial, Calderón de la Barca 359, 11559 Mexico City, Mexico.*
[c] *Nofima AS, P. O. Box 210, 1431 Ås, Norway*

*Corresponding authors.
[a] Sensory and Consumer Laboratory, Biotechnology Department, Universidad Autónoma Metropolitana, Av. San Rafael Atlixco No. 186, 09340, Mexico City, Mexico. Tel +52 (55) 58 04 46 00.
E-mail address: araceli_ac50@hotmail.com (A. Arellano-Covarrubias)
hbeb@xanum.uam.mx (H.B. Escalona-Buendía)

[b] XOC editorial, Calderón de la Barca 359, 11559 Mexico City, Mexico.
E-mail address: carlos@xoceditorial.com (C. Gómez-Corona)

ABSTRACT

Culture is an important driver of food preferences and largely determines exposure to ingredients combinations. The cultural variety in culinary practices across countries raises the question of how flavor combinations are built and how they transcend individual differences in consumers' preferences. For example, in Latin America, despite having similar cultures and language, the diversity in culinary practices leads to different flavor combinations across nations. Therefore, we hypothesize that each country will show different preferences in flavor combinations that could be understood by social media exploration as an innovative approach.

One study was conducted exploring social media in four countries (Argentina, Colombia, Peru, and Mexico) on a one-year basis, using a list of fifty-seven keywords associated with beer flavors. In a first analysis, the list of mentions from consumers was categorized in frequencies of flavors per country and analyzed using correspondence analysis (CA) and agglomerative hierarchical clustering (AHC). Results showed that the countries could be clustered in three groups. Cluster 1 with Mexico and Peru, and the rest of the countries in different clusters. The co-occurrence of paired flavors in social media was used to build a similarity matrix that was analyzed using multidimensional scaling (MDS) in order to find a pattern of pairing per country. The obtained map was useful to understand the cultural differences in flavor paring per country. Overall, the analysis of flavor pairing through social media was an effective technique to access the structure of flavor pairing for beer in different countries.

Key words: Social media, flavor pairing, food pairing, beer pairing, cross-cultural, Latin America.

1. Introduction

The act of eating and cooking has been at the center of human attention for thousands of years. According to Ahn et al. (2011), the human being has historically faced the difficult task of identifying and gathering food that satisfies nutritional needs. However, our relationship with food is far more complex than nutritional; it combines at least two dimensions. The first one ranges from the biological to the cultural, and from the nutritional function to the symbolic (Fischler, 1988). The way we eat and combine food is affected by these dimensions. While food science has focused on the nutritional aspects, the cultural issues of food combination, or food pairing, has been less frequently explored.

1.1 Food pairing

In the last decade, food pairing has received more attention from several disciplines like gastronomy (Paulsen et al., 2015), sensory science (Eschevins et al., 2018), and history (Varshney et al., 2013). Most of the authors agree that food pairing states that if two ingredients share the major chemical compounds, the mixture of elements might taste (and smell) delicious when the foods are eaten together (Simas et al., 2017; Kort et al., 2010; Tallab et al., 2016).

Klepper (2011) defined food pairing as a theory- In his article entitled Food Pairing Theory, the author mentions that the central hypothesis is that the more aromatic compounds two foods have in common, the better they taste together. This theory was developed to create new combinations of food that could be more pleasant for consumers and it has been popular among food scientists and chefs over the past years. Following this same approach, Tallab et al. (2016) state that volatile chemical compounds could be the main attributes responsible for food pairing theory, while basic tastes (sweet, acid, salty, bitter, and umami) play a secondary role (Burdock, 2004). This conclusion seems pertinent when it has been reported that 80 percent of food’s flavor is determined by how our nose picks up volatile aromatic compounds, and the other 20 percent lies in mouth-feel and taste (Klepper, 2011).

Besides the demonstrated relevance of specific aromatic compounds in the perception of food pairing, other components of food, such as proteins, carbohydrates and lipids, can influence the perception of the food pairing. In other words, it is not only aroma that makes the pairing but also the texture, temperature, color, sound and trigeminal sensations (Varshney et al., 2013). Hence, it could be pertinent to restrict the study range of food pairing to its underlying dimensions or variables. Therefore, the pairing which focuses on aroma and basic taste, which seem the most relevant, could receive the name of flavor pairing.

1.2 Flavor pairing

When focusing only on flavor pairing, the study of the flavor compound profile is a natural starting point for a systematic search for principles that might underlie our choice of acceptable ingredient combinations (Ahn, et al., 2011). This is based on the flavor pairing hypothesis which states that culinary ingredients with common chemical flavor components would combine well to produce pleasant dishes (Varshney et al., 2013). However, limiting the hypothesis only to the chemical components of ingredients could be rather incomplete, since not only the chemistry and physics of flavors are taken into account when we evaluate a flavor combination, and the perception of flavors that might differ in each culture. Also, there are multiple variables that influence food choice behavior, such as learning and memory, motivation and emotions, decision making, cognition, social behavior, and perception (Köster et al., 2006) which is a dynamic process that should involve different scientific approaches.

Møller (2013) proposes that the gastronomic field should be studied from different perspectives and must include at least anthropological, psychophysical and neuroscientific perspectives. Starting from an anthropological perspective, the culture from which an individual belongs influences his food preferences and choices. For example, in the Mexican culture, children are taught to eat and appreciate chili, and transform an intense, pungent and hot sensation into a pleasant one (Rozin et al., 1980). For Harrington (2005a), the flavor combination of food and beverages of a specific location involves the environment, which includes geography and climate, and the culture, which is provided by the history and ethnic influences; both of these impact on the prevailing taste components, textures, and flavors in food and drink.

Culture and local ingredients influence flavor preferences and combinations, nevertheless, there might also be elements of universality in flavor and food combinations, which means that different foods in different cultures with similar sensory profiles will induce the same desires in different cultures (Møller, 2013). These aspects of the variety and similarity of flavor combinations across nations have raised the question of whether there is a pattern of successful flavor pairings. In this study the objective is to understand if there exists a pattern of successful flavor pairings across consumers of different cultures, using beer as the case of study. More specifically, we want to explore the beer flavor pairing in four different countries that we hypothesize will have different perceptions, and to understand the cultural influences responsible for flavor pairing in each nation.

The study is geographically limited to four Latin American countries, and beer was selected as the case study since it is a popular beverage across different countries in the region. It has been reported by Euromonitor (2017) that the beer market in Latin American countries is highly consolidated and is expected to keep growing over the next few years. Moreover, beer is one of the most commonly consumed alcoholic beverages in Latin American countries, which consequently have the potential to generate more diversity in their products and enable the pairing comparison between countries.

We propose researching flavor pairing of beer using social media as a method of extracting data in the selected countries. The main advantage of using social media to study flavor pairing is the fact that it provides instant access to a significantly vast amount of information in a specific time, and avoids the bias or limitation of asking people questions. In this sense, it allows us to collect spontaneous flavor pairings in the selected countries, which could be used in the future as an approach to further research into the flavor pairing hypothesis in different cultures, to create new beer flavor combinations that could be applied or even make a successful contribution to the product development field.

2. Materials & methods

Two social media studies were conducted, similar in methodology, but differing in specifics related to the empirical protocol and objective.

2.1 Countries and flavors selection

The selection of countries was carried out using the Google Trends site (https://trends.google.com/trends/), extracting the top four countries with the highest number of mentions in 2013 – 2017 for the words: pairing, beer, food, flavor, gastronomy, and combination. Flavors selection was also performed through Google Trends site from keywords associated with beer: “flavored beer,” “craft beer,” and “beer and flavor combinations”. The query was carried out in the Spanish language and for each country. Despite the same meaning, some flavor names were included twice due to the language differences in some countries. For example, the word “peanut” had different names: “maní” for Argentina, and “cacahuate” for Mexico.

2.2 Social media data

Data was retrieved using Synthesio® social media listening platform. (https://www.synthesio.com/). Synthesio is a paid platform that gives access to both social and mainstream media. It allows researchers to look for information with specific keywords, in 197 countries, over more than 80 languages, and within a determined time frame. A great advantage of this platform is the unlimited characters that can be searched for and analyzed compared with other platforms.

Specifically for this research, it allows geographical restriction of the search by country and even region. It also automatically accesses public demographic information such as gender and age, only when the social media user makes the profile public.

Regarding the data analysis, Vidal et al. (2015), in their study involving Twitter, proposed discarding all re-tweets to avoid inclusion of repeated data. However, for the aim of this study, the re-tweets and all the repeated information gathered were not eliminated, due to the assumption that if more than one user shares and publishes the same information, and specifically the same flavor pairing, the more accepted and more popular was the pairing between the users. For the current research, flavor pairings are represented by the associated flavor names in mentions extracted from social media data, as a mechanism of approach to obtain the more frequent flavor pairings within social media users.

2.3 Experimental protocol

2.3.1 Study 1 - Beer flavor pairing in social media

In this study the objective was to explore the pairing between beers and other flavors. A Boolean search was performed in Synthesio platform for each of the selected countries. The time frame was set on a year's basis: July 18, 2016, to July 18, 2017. For the Boolean search (Supplementary Table 1) the words "beer" and "beers", were associated with "flavor", "taste", "drink", "to drink" and the list of sixty-five flavors retrieved from Google Trends, including double flavor searches due to different names in some countries (e.g. Plátano for Mexico and banana for Argentina).

2.3.2 Study 2 - Flavor pairing per country

In study 2 the objective was to gain a greater understanding of the pairing between flavors per country, based on the same list of sixty-five flavors. For this research, using the Synthesio® platform, the Boolean search was made as an association between paired flavor-related words (Supplementary Table 2). The first search criteria were defined by the main keyword, corresponding to the first of the sixty-five selected flavors, related with any of the sixty-four remaining flavors, with no more than 9 words of distance (connector “NEAR/9”) between them, which is the distance limit between word searches in Synthesio®; they were also associated with the keywords “flavor”, “taste”, “drink”, “to drink”, “flavors”, “combine”, “food”, or “eat”, in order to restrict the searches within food and beverages.

Data collection was performed in July 2017.

2.4 Data Analysis

For both studies, the information contained multiple phrases, tweets, Facebook publications, and extracts from forums or blogs, where the keywords (flavor-related words) were mentioned by users. The data retrieved included an ID number for each mention, the country and date when the mention was published, the website name where it was posted, the URL from which it was extracted, and the user name and gender, if available. For both studies, the information could be downloaded in complete format (e.g. all the tweets by country) in a summary table of frequencies. Word counting was applied to all data (social media and mainstream) to obtain the more popular flavor-related word associations in each country, as it has been a common method for analyzing information about food studies involving Twitter (Platania et al., 2018).

2.4.1 Beer flavor pairing analysis

For this study, all the social media mentions were categorized in frequencies of flavor-related words per country through an automatic count using Synthesio®, some flavor-related word frequencies were grouped due to their similar nature: the group “berries” included cranberry, raspberry, berry, and blackberry; “stone fruits” included yellow peach, cherry, plum, and peach, and “cereals” included malt, oats, and wheat. Also, the flavor related-words with a different name in each country were grouped together, e.g. “grapefruit” included “pomelo” from Argentina and "toronja" from Mexico. After the grouping, percentages of each flavor name per country were calculated and flavor-related words with a lower occurrence value than 1% for all countries were discarded to avoid low frequency data.

Significant differences among countries in the frequency of occurrence of flavor names per country were evaluated using a chi-square test; additionally, the source of variation of global chi-square was identified using a chi-square per cell test (Symoneaux et al., 2012), calculated with a macro formula in Excel. The contingency table was analyzed through a correspondence analysis (CA) followed by an agglomerative hierarchical clustering (AHC) with the Ward algorithm on the first two factors where the identified clusters were described by the abrupt change of similarity level (Lebart et al., 2006). CA and AHC were performed with XL-Stat software version 2012.5.02.

2.4.2 Flavor pairing analysis

In study 2, with the data from each of the sixty-five flavor-related words, an automatic count for the remaining sixty-four flavor names was carried out using Synthesio® to obtain the frequencies in which 2 flavor-related words were combined in order to build a frequency matrix of flavor names per country. Some flavor-related word frequencies were grouped together due to their different names in the countries studied. A pre-treatment of the co-occurrence data was performed, building a similarity matrix to compute the proximity between flavor-related words using the Pearson correlation coefficient. The matrices obtained were the base used to carry out a multidimensional scaling (MDS) analysis in order to find a pattern of pairing per country through a sensory flavor map. The first two dimensions of each MDS were used to perform multiple RV coefficient analyses to test the similarities between two matrices; and finally, an agglomerative hierarchical clustering (AHC) with the Ward algorithm on the first two dimensions of MDS was performed. The statistical analysis was performed with XL-Stat software version 2012.5.02.

Finally, for both studies, in order to identify whether the more popular flavor-related words obtained from the previous statistical analyses belonged to flavor associations or only to associated words, a thematic analysis through familiarization with data and identification of relevant themes was performed.

3. Results

The discussion of the results obtained from the mentions on social media is divided into two sections: beer flavor pairing, and flavor pairing by country. The former focuses on the flavor pairings around beer across countries, while the latter establishes an insight into the structure of general flavor pairing in the different countries.

The countries with a higher number of mentions in Google Trends were Mexico, Argentina, Colombia, and Peru, and regarding the flavors selection, a final list of sixty-five flavors was obtained (including the double searches due to language differences).

3.1 Beer flavor pairing

The data retrieved through the Synthesio® platform was arranged by number of mentions; a total of 62415 mentions were extracted. Mexico had the highest frequency with 27544, followed by Argentina with 24919, Colombia with 7267, and finally Peru with 2685 mentions. From the total number of mentions, 73% were categorized as social media data (e.g. Facebook, Instagram, etc.) and 27% were mainstream data (e.g. Corporate channels or Internet sites). From the media data, 50% were mentions extracted from Twitter, 16% from general news and magazines, 13% from Instagram, 5% from regional newspapers, 4% from blogs, and the remaining 12% were mentions from other types of social and mainstream media.

The extracted mentions of the sixty-five flavor names retrieved from Synthesio® were arranged into a contingency table of frequencies per country. After grouping the frequencies of flavor-related words with a similar nature and with different names in each country, a total of fifty flavor names were used to perform a new frequency table, and the percentage of occurrence for each country was calculated. Nineteen flavor-related words were discarded due to having less than 1% occurrence of the total mentions for each country. Table 1 contains the frequencies of occurrence of the remaining 31 beer flavor-related words, according to the results of the Chi-square test. All of them differed significantly among the countries (X^2 = 9492.96; p<0.0001), suggesting that cultural differences might influence the beer flavor pairing associations.

A correspondence analysis (CA) was performed on the contingency table data. Figure 1 shows the first two dimensions that account for 95.85% of inertia. The axis 1 separates countries positioning Mexico, Colombia, and Peru close to each other and only Argentina is on the right-hand side of the graph. The axis 2 separates only Colombia from the other countries. The results of the hierarchical cluster analysis (HCA) on flavor-related words show seven beer flavor clusters, which highlight the cultural differences in beer flavor associations for each country. Argentina shows a relationship between wine, cheese, stone fruits, peanut and sweet. Colombia is related to tequila, mango, bitter, pepper, and coffee. And finally, Peru and Mexico in the central zone of the map, are surrounded by chocolate, lime, pineapple and coconut, establishing similarity between their beer flavor associations. These associations were confirmed by the AHC performed on the countries, where Mexico and Peru were grouped in the same cluster, while the rest of the countries were grouped in individual clusters.

3.2 Flavor pairing

The flavor pairing data, represented by the associated flavor names, were arranged in a 65x65 flavor matrix per country, showing the frequencies where each two flavor-related words were combined. After grouping the frequencies of the flavor-related words with different names in each country, a 57x57 flavor matrix per country was arranged, and a similarity matrix per country was performed; MDS analysis was carried out for each matrix. Kruskal’s stresses for the first two dimensions of the MDS analysis of each country were 0.354, 0.365, 0.365, and

0.371 for Mexico, Argentina, Colombia, and Peru, respectively. According to Borg et al. (1997), Kruskal's values less than 0.20 can be considered as an acceptably precise MDS solution, however, higher values might also be acceptable for the representation of the data if the decrease in stress begins to be less pronounced in the stress vs. dimensionality graph, when essentially the MDS analysis only scales the noise of the data. For all the matrices studied, the decrease is shown between two and three dimensions, and for interpretation purposes of the flavor maps, results for two dimensions were chosen. RV coefficients between each pair of matrices were used as a measurement of similarity, as Vidal et al. (2014) had previously reported that RV coefficient is a good predictor of similarity between pairs of sample configurations. Blancher et al. (2012) proposed an RV coefficient higher than 0.95 to consider stability of sample configurations. The values of the RV coefficients in the present study (Table 2) are generally low, showing that matrices obtained are not similar to each other and, consequently, that flavor associations are different in each country.

The agglomerative hierarchical clustering (AHC) analysis was performed to link the flavor words with similarities within the countries and, consequently, to find the flavor-related words being paired with greater frequency. Results of the AHC of the two first dimensions of MDS grouped the flavor-related words in 10, 11, 12, and 10 clusters for Mexico, Argentina, Colombia, and Peru, respectively (Supplementary Table 3). The words tequila, mezcal, and chili were grouped for all countries in the same cluster, except in Mexico where chili was grouped with some kinds of fruit like tamarind and grape, and also with the hibiscus flavor-related word. Tamarind and hibiscus were grouped together in all countries, except in Argentina. It is important to highlight that coffee and toasted were grouped together in all countries and a similar situation occurred with peanut and butter, however, these last combinations would probably refer to either an intrinsic characteristic of coffee or to the known product "peanut butter" instead of a common flavor pairing. Flavor-related words directly related to beer (yeast, malt, and hop) were grouped in a separate cluster only in Mexico, while in the rest of the countries they were spread in different clusters. Finally, alcoholic beverage flavor names (tequila, mezcal, and wine) were only grouped together in Mexico and Colombia. No other relevant patterns were found in the rest of the clusters within the countries.

MDS maps for each country are shown in Figure 2, where all flavor-related words per country are distributed. On the Mexico map (Fig. 2a), the words related directly to beer (yeast, malt, and hop) and alcoholic beverages are distributed on the right side of dimension 1, while on the left side of the same dimension the spices and seasoning flavor-related words (vinegar, cinnamon, pepper, ginger) can be found. On the negative side of dimension 2, all berries are positioned on the map, and finally, on the positive side of this dimension, some of the words related to cereals and seeds (wheat, pecan, peanut) can be found. The results of Argentina's flavor map (Fig. 2b) show in the right lower quadrant all words related to beer and alcoholic beverages (yeast, malt, hop, wine, tequila, mezcal, agave), while on the left upper side, all the stone fruits are distributed (peach, plum, yellow peach, cherry); spices and seasoning flavor-related words like cinnamon, ginger, and pepper are distributed on the upper side of dimension 2. Results for Colombia (Fig. 2c) show on the upper side of dimension 2 the words related to alcoholic beverages and beer; in the right lower quadrant, all berries and stone fruits are distributed, whereas in the left lower quadrant the spices and seasoning flavor-related words are positioned. The results of the flavor map of Peru (Fig. 2d) show on the right side of dimension 1 some words related to alcoholic beverages (mezcal, wine, and tequila) along with some acidic (pineapple, orange, lime, grape) and semi-acidic fruits (peach, apple, plum, mango), while on the upper side of dimension 2 are distributed some beer flavor-related words like malt and hop, along with some floral names (floral and hibiscus). Finally, in all the maps, the words fruity and sweet are positioned at the center of the map.

From the MDS analysis, and for each country, the greatest distance of all the combinations of two flavor-related words was extracted and an average was calculated. The greatest average distance obtained was 1.637, and the associations with a value of no more than 0.1637 distance were extracted, which correspond to 10% of the average distance. Those word associations were considered the most commonly paired flavor-related words (Table 3). The extracted number of pairings for each country were 35, 31, 32, and 31 for Mexico, Argentina, Colombia and Peru, respectively. The flavor-related words that were most commonly paired in all countries were cinnamon-ginger and coffee-toasted; ginger-pepper, tequila-mezcal, malt-hop, and butter-peanut were also common flavor-related words paired in the countries. Moreover, a small number of word associations that were frequent in two countries are shown, like **lime-orange** for Mexico and Argentina, and **cranberry-fruity** or **cinnamon-pepper,** for Colombia and Peru. The remaining paired combinations that were not repeated within the countries are not shown in Table 3 for the sake of length, but the interested reader can contact the authors for more details.

4. Discussion

A significant amount of information was extracted using Synthesio®. Sampling size (62415 mentions) was more prominent than the information we could access through traditional consumer research. According to the website wearesocial.com (2018), the number of Internet users for Mexico is 85 million, for Argentina 34.79 million, for Colombia 31 million, and for Peru 22 million. These numbers seem to match the number of extracted mentions for the present study: Mexico had the higher number of mentions (27544), followed by Argentina (24919), Colombia (7267), and Peru (2685).

Almost half of the information gathered from social media was collected from Twitter, possibly due to the fact that tweets are predetermined as public when people register an account on the platform (Twitter, 2018). This in contrast from other sites such as Facebook or Youtube, which according to Lobzhanidze et al. (2013) are not suitable to broadcast information due to their security mechanisms that allow access to published information only by restricted users.

4.1 Beer flavor pairing

Frequencies of occurrence (Table 1) show the flavor-related words with more extracted mentions in each country, but also the differences among the countries.

For example, for Mexico, lime (1205 mentions) and chili (1081 mentions) have significantly more mentions when compared with the rest of the countries. This tendency could be explained by the fact that chili is eaten at almost every meal by Mexicans, being a representative flavor of the Mexican cuisine (Rozin, 1990). Another popular flavor-related word in Mexico is tequila, whose number of mentions exceeded 6000, and where it is a local product considered as "a quintessentially Mexican alcoholic beverage" (CRT, 2018).

In the case of Argentina, wine had a significantly high number of mentions (7191 mentions), and according to the WHO, in the "Global Status Report on Alcohol and Health" (2014), within the countries studied, Argentina had the highest consumption (in liters of pure alcohol) of this product, constituting 48% of total alcohol consumption. Additionally for this country, the cheese flavor-related word reported the highest number of mentions among the countries, which has been widely reported as an ideal combination with wine and beer (Harrington, 2005b; Madrigal-Galan et al., 2006, Bastian et al., 2009; Harrington et al., 2010; Donadini et al., 2013). Regarding Colombia and Peru, the total number of mentions were lower than in other countries; however, tequila, wine, and coffee were the words with higher frequencies.

Donadini, et al. (2008) and Harrington, et al. (2005b) stated that the pairing of beer and food is not random; instead consumers recognize that beer goes better with specific flavors. Figure 1 shows all flavor words widely related to beer within the countries, so in general **Argentina** is related to **wine**, **cheese**, **stone fruits**, and **peanut**. To illustrate the trend of the most cited flavor-related words obtained in figure 1, some relevant quotes were selected by searching for the flavor words within the beer flavor pairing database for each country.

Some of the mentions extracted that match with the flavor-related words tendency in Argentina are the following: "Enjoying with friends at #tabernadeodin, #honey #**peanut** #**beer** #cold"-Instagram; *"**beer** and **wine**, in that order"*- Instagram; and, *"Salami with **cheese** and **beer**"*-Twitter. These examples show some of the characteristic beer flavor associations in Argentina, and specifically, the peanut flavor has a cultural relevance within the country. According to the Cámara Argentina del Maní (CAM, 2018), peanuts are widely consumed in Argentina and are normally served free with beer as a part of tapas in bar and restaurants.

Regarding the beer flavor-related word associations for **Colombia,** we found that this country is related to **coffee**, **pepper**, **mango**, and **tequila**. Some of the mentions extracted that illustrate this behavior are: *"Kiko had for breakfast a kiwi, toast, **coffee** and a **beer**!"*-Twitter; *"Black bock **beer** style reduction of smoked **coffee** with sweet **pepper** and frosted with cinnamon and bitter cocoa"*-Instagram; *"Because there are days for a good **michelada beer** with **mango**"*- Instagram. However, in the case of tequila, we found out that Colombian people do not generally consume it "mixed" with beer; instead they mentioned the flavor-related word as a consumption option between multiple alcoholic beverages or as a sequence of beverages consumption: *"Yesterday, I drank **beer**, wine, **tequila**, whisky, schnapps, and piña colada, I went to bed at 7 am!"*- Twitter.

Finally, Peru and Mexico showed a similar flavor-related word association based on a large number of fruits, like **lime**, **coconut**, **pineapple** or **berries**; the words **chocolate** and **chili** were also related to both countries, indicating that these flavors could be highly paired with beer, as demonstrated by some of following extracted mentions: *"Mojito with frosty **lime** and lager **beer**"*- Instagram (Mexico); *"I enter this new restaurant: a **beer** and a **chocolate** cake, please. "Are we celebrating something?", they asked me"*- Twitter (Peru); "*A crazy **coconut** #coctel #**beer** #**coconut** #cucumber #**lime** #salt #corona #**chillipowder**"*- Instagram (Mexico).

4.2 Cultural flavor pairing

The flavor pairing matrices per country, in which two flavor-related words were combined, were not similar to each other (RV coefficients), and consequently, the preferences for certain flavor associations could be different in each country. As Møller (2013) states, our specific desires are dependent on the food of each country, but similar desires could also be found in different cultures, pinpointing the existence of potential universal patterns.

Ahn et al., (2011) questioned the possibility of the existence of some general patterns, above individual tastes and recipes, which could lead to successful ingredient combinations. In the present research, despite the cultural diversity of countries' cuisines, we could find some of these "universal elements" where the flavors, represented by the extracted words, were clustered together in all countries, or at least in two of them. For example, tequila and mezcal were grouped in all the countries, as were also the combination of coffee and toasted, and the pair peanut and butter. Besides these flavor-related word combinations found by the cluster analysis, the smaller distances on the MDS maps also show other general word associations like cinnamon-ginger, ginger-pepper, malt-hop, lime-orange, and cranberry-fruity.

Within the most commonly associated flavor-related words in all countries, the word association peanut / butter was frequently mentioned, but reviewing the information extracted for this pair of flavor-related words, it was found that people do not pair butter with peanut, instead, they consume the product known as "peanut butter." This example highlights the importance of the content analysis of information gathered as a method of a correct interpretation of social media data (Vidal et al., 2015). Besides the small number of similar flavor associations observed in the countries studied, no other patterns could be found, showing differences in food preferences and specifically in the flavor pairing within the countries.

Regarding the preferences and attitudes for certain products, Kim et al. (2018) stated that the cultural background could promote the similarities through the exchange of information within the population of the same culture, which implies that almost all consumer decisions are socially oriented (Jager, 2006), and where the use of social media in this research has a crucial importance in the exchange of information through a network of people within the countries.

On the other hand, and from a psychological perspective, it has also been stated that Western societies are analytical thinkers, which means that people from these societies would separate an object from its context (Kim et al., 2018); and, in the case of food preferences, Western societies could be less influenced by external factors like the presence of other cultures, but may also have more trust in the population of the same culture, which could explain the differences and popularity of the flavor associations within Latin American countries in the present research.

Within the cultural approach, it could be pertinent to research the flavor pairing as a multidisciplinary perspective, including the intrinsic chemical profile of each ingredient, as Ahn, et al. (2013) state that modern Western cuisines follow the flavor pairing principle which is defined by the aromatic compounds' similarities between two flavors. Also, Simas et al. (2017) found that the flavor compounds of ingredients are strongly paired or bridged in Latin America, where the term "food-bridging" arises when two ingredients do not share a strong molecular affinity, but a third ingredient links the first two ingredients through a chain of chemical affinities. However, these similarities between the flavor pairings attributed to the chemical compounds may be due to either the intrinsic composition of flavors or to the influence of the culture to which each individual belongs.

The findings of this research demonstrate the diversity of the food culture that has been developed by humanity (Min et al., 2017), and also, that the culture to which we belong impacts directly on our perception of food and flavors (Harrington, 2005a), and consequently, on the preferences and choices across countries.
Finally, there is reported interest in new experimental beers beyond the traditional ones within Latin American consumers (Euromonitor, 2017), so this research could lead to the implementation of new products based on the beer flavor combinations obtained that could be successful in the beer market, and consequently have a positive economic impact in the field. The current research only proposes an insight, using social media as a tool of research, which could be exploited, whether for a better understanding of cultural differences (and similarities) in consumer

behavior within countries, or for the application of the information gathered in order to propose new flavor combinations. However, further exploration should be carried out regarding social media data to guarantee that the information extracted reflects the accepted flavor combinations among consumers.

5. Conclusions

The results of this study show that social media analysis could be a good methodology to research the relationship between flavors in beer pairing across countries. It was possible to identify some flavor associations per country (associated to beer) and to explore the cultural relevance, as many differences and similarities between countries were identified. However, this approach has advantages and disadvantages. On the one hand, social media analysis enables the researcher to access a wide number of countries and regions in a way that could otherwise be very time and resource consuming. On the other hand, some consumers are being left out of the analysis, such as low income and senior consumers, due to the infrequent use of social media in those segments of the population, especially in developing countries like Mexico, Argentina, Colombia and Peru.

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Table 1

Frequency of occurrence of the selected beer flavors. Values shown are the number of beer flavor mentions per country.

Flavor	Mexico	Argentina	Colombia	Peru
Tequila	6024 (+) ***	1317 (-) ***	1709 (+) ***	205 (-) ***
Wine	3790 (-) ***	7191 (+) ***	1286	312 (-) ***
Coffee	2845	1856 (-) ***	789 (+) ***	173
Mezcal	2179 (+) ***	50 (-) ***	83 (-) ***	6 (-) ***
Chocolate	1338 (+) ***	829 (-) **	193 (-) ***	98 (+) **
Cereals	1307	959	306	113 (+) ***
Floral	1281 (+) ***	501 (-) ***	131 (-) ***	104 (+) ***
Lime	1205 (+) ***	645 (-) ***	213	116 (+) ***
Cheese	1096 (-) ***	1301 (+) ***	226 (-) ***	49 (-) ***
Chili	1081 (+) *	723	158 (-) ***	110 (+) ***
Fruity	931 (-) **	832 (+) ***	189	66
Sweet	860 (-) ***	990 (+) ***	167 (-) ***	56
Berries	691 (+) ***	135 (-) ***	88	14 (-) **
Woody	627 (-) **	607 (+) ***	84 (-) ***	41
Yeast	576 (-) *	534 (+) ***	73 (-) ***	47
Honey	517 (-) ***	556 (+) ***	70 (-) ***	47
Hop	486 (-) ***	557 (+) ***	85 (-) ***	42
Apple	470 (-) ***	699 (+) ***	71 (-) ***	38
Pineapple	456 (+) ***	120 (-) ***	75	32 (+) *
Acid	454 (+) **	243 (-) ***	62 (-) **	62 (+) ***
Bitter	435	330	136 (+) ***	23
Orange	419 (-) ***	660 (+) ***	70 (-) ***	36
Butter	400 (+) ***	100 (-) ***	49	25
Mango	386 (+) ***	113 (-) ***	107 (+) ***	26
Pecan	344 (+) ***	207	22 (-) ***	13
Coconut	336 (+) *	207	64	12
Strawberry	330 (+) ***	36 (-) ***	44	18
Peanut	196 (-) ***	605 (+) ***	38 (-) ***	10 (-) **
Stone fruits	199 (-) ***	258 (+) ***	42	13
Pepper	171 (-) ***	177	74 (+) ***	30 (+) ***
Hibiscus	246 (+) ***	32 (-) ***	32	33 (+) ***

Effect of the chi-square cell per cell test (+) or (-) indicate that the observed value is higher or lower than the expected value: *p<0.05; **p<0.01; ***p<0.001.

Table 2

RV coefficients results of pair of matrices

Countries	RV coefficients	P-value
Mexico-Argentina	0.20	<0.001
Mexico-Colombia	0.29	<0.001
Mexico-Peru	0.29	<0.001
Argentina-Colombia	0.32	<0.001
Argentina-Peru	0.01	0.846
Colombia-Peru	0.18	<0.001

The closer the RV coefficients to zero, the more dissimilar are the pair of matrices

Table 3

Most paired flavors for Mexico, Argentina, Colombia, and Peru

Mexico	Argentina	Colombia	Peru
Cinnamon – Ginger	Cinnamon – Ginger	Cinnamon – Ginger	Cinnamon – Ginger
Coffee – Toasted	Coffee – Toasted	Coffee – Toasted	Coffee – Toasted
Ginger – Pepper	Ginger – Pepper	----------	Ginger – Pepper
Tequila – Mezcal	Tequila – Mezcal	Tequila – Mezcal	----------
Malt – Hop	Malt – Hop	Malt – Hop	----------
----------	Butter – Peanut	Butter – Peanut	Butter – Peanut
Lime – Orange	Lime – Orange	----------	----------
----------	----------	Cranberry – Fruity	Cranberry – Fruity
----------	----------	Cinnamon - Pepper	Cinnamon – Pepper
----------	----------	Chilli – Tequila	Chilli – Tequila
Peach -Plum	Peach -Plum	----------	----------
Mango – Passion fruit	----------	----------	Mango – Passion fruit
Mango - Orange	----------	Mango – Orange	----------
Raisins -Anise	----------	Raisins – Anise	----------
Watermelon -Oats	----------	----------	Watermelon -Oats
Grapefruit - Oats	----------	----------	Grapefruit – Oats
----------	Wheat - Oats	Wheat – Oats	----------
----------	----------	Coffee – Grapefruit	Coffee - Grapefruit
----------	----------	Stawberry – Passion fruit	Strawberry – Passion fruit
----------	----------	Hibiscus - Tamarind	Hibiscus – Tamarind

The table shows the pairings that are repeated in at least two countries.

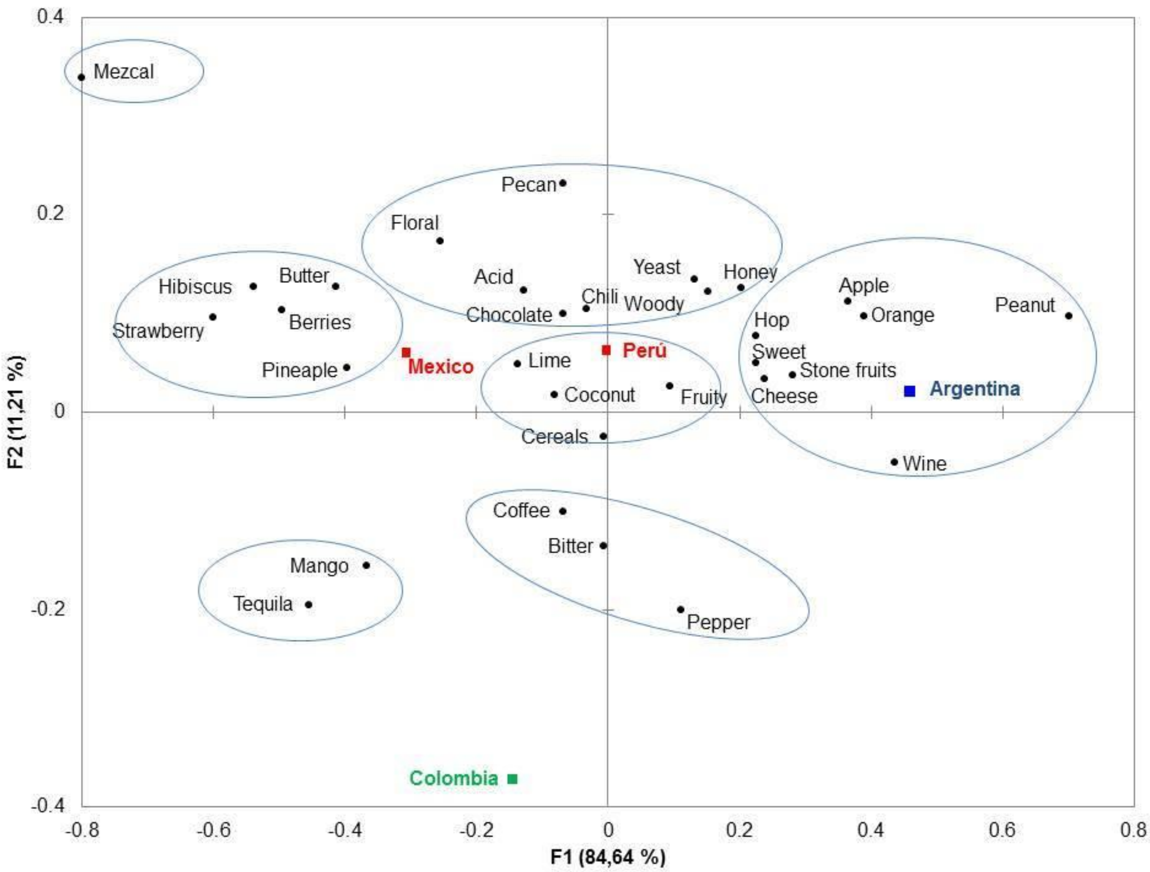

Fig. 1 CA of beer flavors in black circles and countries in squares. The hierarchical clustering of the CA shows that flavors can be clustered in 7 groups. Hierarchical clustering for countries grouped Mexico and Peru (in red) in the same cluster, while Argentina (in blue) and Colombia (in green) are grouped in individual clusters.

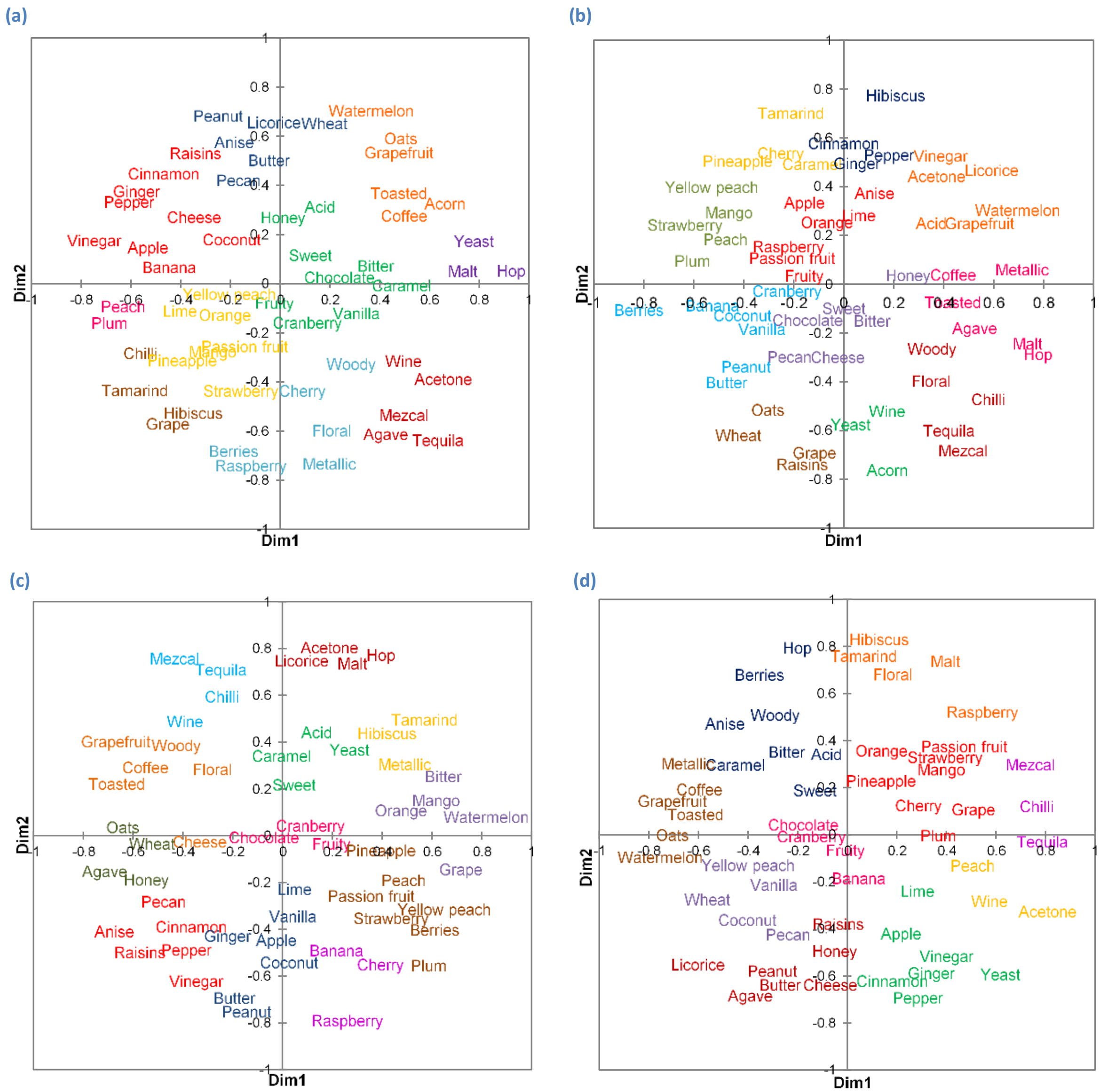

Fig. 2 Flavor maps. Two dimensional graphs for (a) Mexico, (b) Argentina, (c) Colombia, and (d) Peru. Kruskal's stress values are 0.354, 0.365, 0.365, and 0.371 for Mexico, Argentina, Colombia, and Peru, respectively. The hierarchical clustering of each MDS map is represented by similar colors.