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Research Article

Determination of physical, chemical and sensory characteristics of *yentafo* sauces

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Abstract

The objectives of this research were to investigate (1) physical, chemical properties and sensory characteristics of commercial and laboratory prepared Yentafo sauces and (2) the relationship among instrumental parameters and sensory attributes by principal component analysis (PCA) and factor analysis (FA). The physical from eight Yentafo sauces were viscosity in the range of 4022– 8866 cP, consistency in the range of 3-15 min./sec. and color value (L*) in the range of 22- 57,(C*) in the range of 38-58 and h in the range of 26 -53 degree. Their chemical properties were total solid content, total soluble solid content, salt content (sodium chloride), total acidity and pH in the range of 11- 40, 8- 38, 2 - 8, 0.20 - 1.17 and 3.54 - 4.32, respectively. Their sensory descriptive analyses by 8 trained panelists consisted of 3 attributes for appearance, 8 attributes for aroma, 10 attributes for flavor, 2 attributes for oral texture and 7 attributes for aftertaste. The result from PCA of descriptive data demonstrated that two principal components (PCs) which were chili flavors (PC1- 50.13%) and spices aroma (PC2-19.68%) having 69.81% of explained variable. Results from FA and PCA could classify samples into six groups. In addition, investigation of the relationship among instrumental parameters and sensory attributes by PCA also found two PCs having 60.04% of explained variable (PC1- 35.30% and PC2- 24.74%). Pearson correlation analysis of the data indicated three groups of positive correlation between 1) total acidity and pickled garlic factor 2) color value (h), total soluble solid content, total solid content and appearance/ coriander factor and 3) salt content (sodium chloride) and salty factor. There were two groups of negative correlation between 1) pH and pickled garlic factor and 2) consistency and texture/ red bean curd factor.

Keywords: Descriptive analysis, Yentafo sauce, PCA, Thailand

Introduction

Sauce is one instant food which is used for dipping or used as the condiment. It is generally used with meat dishes. Nowadays, sauce has been developed in many categories such as banana sauce, mango sauce and carrot sauce. Yentafo noodle is also one of the very famous noodles in Thailand. It is consisted of various ingredients for examples; pieces of coagulated blood, pickled squids and fish balls with a very unique taste. The main ingredient, which makes the Yentafo noodles more different and outstanding than other kinds of noodle, is Yentafo sauce. [1] At present many Yentafo sauce manufacturers use synthetic colorants rather than natural ones to give the sauce red color. The most popular synthetic colorant used is Poncoau 4 R, which can be harm to the consumers if it is over consumed. However, Poncoau 4 R is allowed in many countries such as Syria; it is allowed to be used in food up to about 3% [2], European countries, it is allowed to be used singly or combination in the food and it can be used not exceed 50 mg/kg or mg/l [3].

Sensory descriptive analysis is one of the methods, used to evaluate unique attributes and intensities of sample. This technique can be used to estimate characteristics such as appearance, aroma, flavor and taste.

The objectives of this research were to investigate (1) physical, chemical analysis and sensory characteristics of commercial and laboratory prepared Yentafo sauces and (2) the relationship among instrument parameters and sensory attributes by principal component analysis.

Materials and Methods

Samples

Samples A1 – A4 were commercial Yentafo sauces available in the markets around Bangkok and samples B1 – B4 were laboratory prepared sauces.

Quality measurement of Yentafo sauce

- Physical analysis included color value (L*, C*, h), viscosity and consistency.
- Chemical analysis included total solid content (TS), total soluble solid content (TSS), salt content (NaCl), total acidity (TA) [4] and pH.

Sensory evaluation

Eight trained panelists were selected through preliminary research from Kasetsart University Sensory and Consumer Research Unit (KUSCR).

Panelists were asked to develop sensory characteristics of Yentofo sauce using Quantitative Descriptive Analysis technique (QDA), including definitions and references of each attribute.

Twenty ml. of eight Yentafo sauce samples (A1 – A4 and B1 – B4) were prepared in a white plastic cup with covered lid and labeled with random 3-digit number and served to the panelists. They were then asked to rate the intensities of each attribute using a line scale of 150 mm. [5], which intensities range from 0-15 (0 = no intensity, 15 = extremely strong). Samples were presented to a panelist with 3 replications.

Statistical analysis
Sensory characteristics were classified by principal component analysis (PCA), and then similar attributes were grouped using Factor Analysis (FA) technique.

The physical, chemical and sensory characteristics were classified by PCA using XLSTAT® version 2006 to investigate a relationship among instrumental parameters and sensory attributes.

Results and Discussion

Classification of physical characteristics
Analyzed physical characteristics mean scores by PCA, the results showed two main principal components (PCs) having an explained total variance of 77.80% (Figure 1). The first component (PC1) explained 56.23% of the variation and positively related to color saturation (C*) and consistency, in contrary the color lightness (L*) related to viscosity. The second component (PC2) explained 21.57% of the variation and positively related to color value (h).

Relationship of physical characteristics and Yentafo sauces showed that Yentafo sauce A1, A4 and B1 related to C*value, Yentafo sauce A3 related to h value, Yentafo sauce B4 and B2 related to L* value and Yentafo sauce B3 related to viscosity.

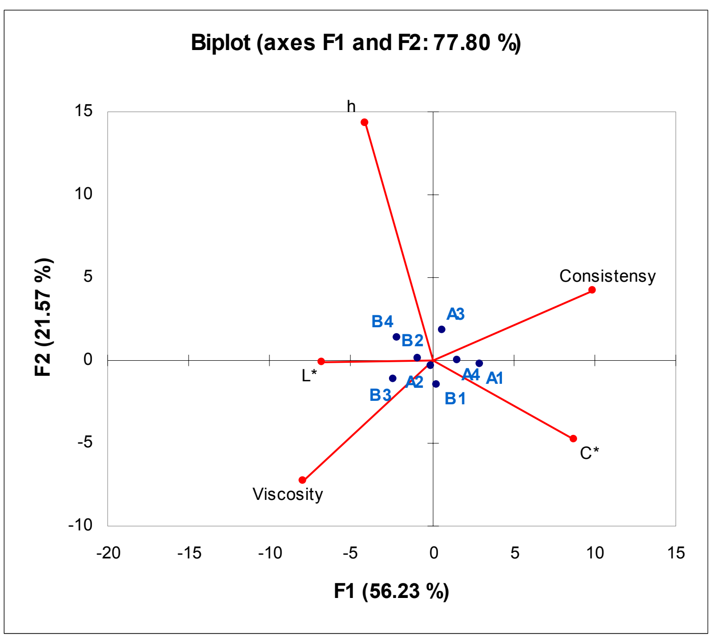

Figure 1. PCA biplot describing physical characteristics of eight Yentafo sauces.

Classification of chemical characteristics

Figure 2 shows the results of chemical characteristics mean scores analyzed by PCA. Two main principal components (PCs) having an explained total variance of 81.60%. The first component (PC1) explained 46.77% of the variation and positively related to total soluble solid content, total solid content, salt content (NaCl) while the second component (PC2) explained 34.84% of the variation and positively related to total acidity but negatively related to pH.

The PCA biplot also indicated that Yentafo sauce A1 related to total acidity, Yentafo sauce A2 and A3 related to total soluble solid content, total solid content, salt content and Yentafo sauce A4, B2, B3 and B4 related to pH.

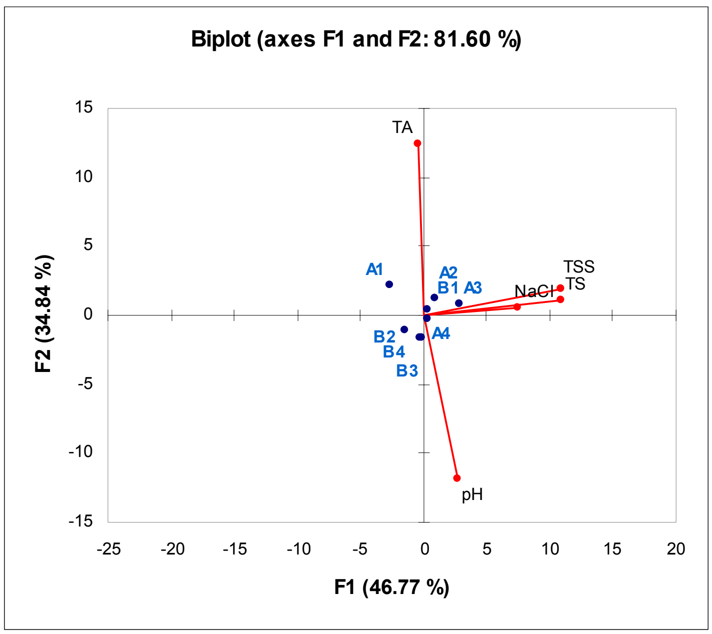

Figure 2. PCA biplot describing chemical characteristics of eight Yentafo sauces.

Sensory characteristics of eight Yentafo sauces

From sensory evaluation using QDA technique, eight trained panelists could develop 30 attributes of Yentafo sauces, their definitions and references are shown in Table 1.

Tabel 1. Definitions and references used in the descriptive analysis of Yentafo sauces.

Attributes	Definition	Reference	Intensity
Appearance (AP)			
Color	The intensity of color from pink to red and orange	Color scale	1-15
Viscosity	The intensity of viscosity.	Red sauce	6
Amount of chili / garlic	The overall amount of chili and garlic consisted in sample.	Chicken dipping sauce Hot chili sauce, Heinz brand.	12 5
Aroma (A)			
Red bean curd	The intensity of sour and salty odor from fermented soybean.	Red bean curd	9
Garlic	The intensity of pickled garlic.	Pickled garlic	9
Pickled garlic	The intensity of sweet and sour odor from pickled garlic.	Pickled garlic liquid	8
Chili	The sharp penetrating sensation of chili in the nose.	Chili liquid (green + red) 15%	8
Musty	The aromatic associated with closed air spaces that are perceived by the nose.	Chili sauce, Pegasus brand	5

Tabel 1 (cont.) Definitions and references used in the descriptive analysis of Yentafo sauces.

Attributes	Definition	Reference	Intensity
Aroma (A)			
Green chili	The intensity of similar green chili odor.	Spur pepper chili (green)	7
Dry chili	The intensity of dry odor from dried chili.	Dried red chili	5
Coriander	The intensity of coriander odor.	Boiled coriander root	8
Flavor (F)			
Red bean curd	The intensity of sour and salty odor from fermented soybean perceived in the mouth.	Red bean curd	7
Pickled garlic	The intensity of sweet and sour odor from pickled garlic perceived in the mouth.	Pickled garlic liquid	6
Chili	The sharp penetrating sensation of chili perceived in the mouth.	Chili liquid (green + red) 15%	6
Musty	The aromatic associated with closed air spaces that are perceived in the mouth.	Chili sauce, Pegasus brand	6
Coriander	The intensity of coriander odor perceived in the mouth.	Boiled coriander root	5
Sweet	The fundamental taste factor associated with a	5.0 % sucrose solution 10.0 % sucrose solution	5

	sucrose solution perceived by one's tongue.		10
Sour	The fundamental taste factor associated with a citric acid solution perceived by one's tongue.	0.05 % sucrose solution 0.08 % sucrose solution	2 5
Salty	The fundamental taste factor associated with a sodium chloride solution perceived by one's tongue.	0.20 % sucrose solution 0.70 % sucrose solution	2.5 7
Umami	The fundamental taste factor associated with a monosodium glutamate solution perceived by one's tongue.	0.75 % monosodium glutamate solution	7
Heat	Burning and sting sensation in the oral cavity.	Sriracha chili sauce, Heinz brand. Hot chili sauce, Heinz brand.	4 6
Oral Texture (OT)			
Smooth	The overall amount of smoothness in the mouth.	Chili sauce, Pegasus brand Chicken dipping sauce	14 3

Tabel 1 (cont.) Definitions and references used in the descriptive analysis of Yentafo sauces.

Attributes	Definition	Reference	Intensity
Oral Texture (OT)			
Starchy	The intensity of cooked flour in the mouth.	Cooked flour	9
Aftertaste (AF)			
Sweet	The fundamental taste factor associated with a sucrose solution perceived after swallowing.	2.0 % sucrose solution 5.0 % sucrose solution 10.0 % sucrose solution	2 5 10
Sour	The fundamental taste factor associated with a citric acid solution perceived by one's tongue.	0.05 % sucrose solution 0.08 % sucrose solution	2 5
Salty	The fundamental taste factor associated with a sodium chloride solution perceived by one's tongue.	0.20 % sucrose solution 0.70 % sucrose solution	2.5 7
Umami	The fundamental taste factor associated with a monosodium glutamate solution perceived by one's tongue.	0.75 % monosodium glutamate solution	7
Heat	The intensity of burning and sting sensation perceived after swallowing.	Sriracha chili sauce, Heinz brand. Hot chili sauce, Heinz brand.	4 6
Pickled garlic	The intensity of sweet and sour odor from pickled garlic perceived after swallowing.	Pickled garlic liquid	6
Red bean curd	The intensity of sour and salty odor from fermented soybean perceived after swallowing.	Red bean curd	7

Classification of sensory characteristics

All samples had statistically significantly difference in sensory characteristics ($p \leq 0.05$), since their ingredients and preparation processes are different. All 30 average intensity scores of each attribute of eight Yentafo sauces had been analyzed using PCA, in order to obtain relationships among them and the relationship between sensory characteristics and eight Yentafo sauces (A1 – A4 and B1 – B4).

The results (Figure 3) showed two main principal components (PCs) having an explained total variance of 69.81%. The first component (PC1) explained 50.13% of the variation and positively related to viscosity, chili/garlic (AP), garlic (A), green chili (A), red bean curd (F), chili (A,F), starchy (OT), salty (F, AF) and heat (F, AF), but negatively related to color (AP), pickled garlic (A, F, AF), musty (A, F), smooth (OT), sweet (F, AF), umami (F, AF) and sour (F, AF);while the second component (PC2) explained 19.68% of the variation and positively related to dry chili (A), and coriander (A, F) but negatively related to red bean curd (A, F).

Relationship of sensory characteristics and Yentafo sauce revealed that Yentafo sauce A1 and A4 related to pickled garlic (A, AF), sour (AF) and musty (A, F), Yentafo sauce A2 related to pickled garlic (A, F), sour (F) and sweet (AF), Yentafo sauce A3 related to dry chili (A), and coriander (A, F), Yentafo sauce B1 and B2 related to chili/garlic (AP), chili, green chili, garlic (A), salty (F) and heat (F, AF) and Yentafo sauce B3 and B4 related to viscosity, starchy (OT) and red bean curd (A, F, AF).

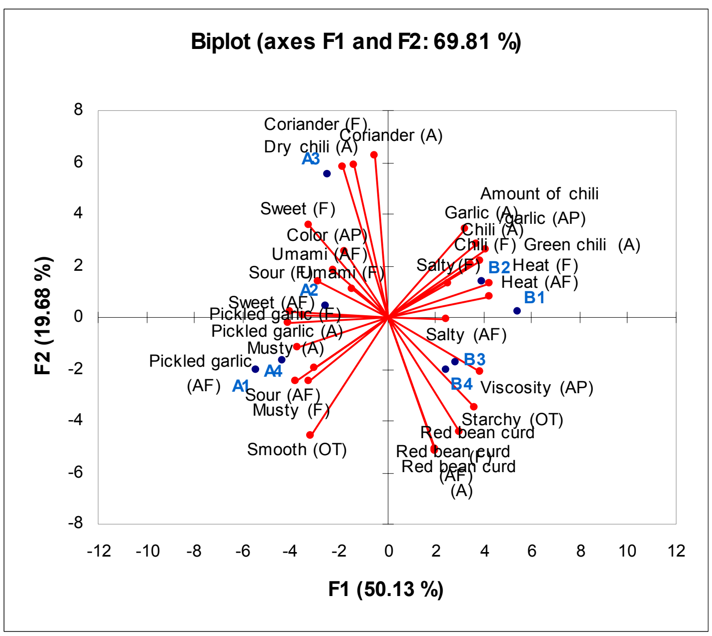

Figure 3. PCA biplot describing descriptive sensory characteristics of eight Yentafo sauces.

Variable classification

Thirty sensory characteristics were subsequently evaluated and quantitatively described. The variables were then classified into six factors (groups) using factor analysis technique (Table 2), by considering eigenvalue greater than 1 [6, 7] and rotation method by Varimax with Kaiser Normalization. The classified six factors are as follows;

Factor 1 can explain variance of the original 30 variables with 31.09 % and the best variables in this factor are chili (A, F), garlic (A), green chili (A), smooth (OT), heat (F, AF), chili/garlic (AP), sweet (AF), musty (F) and sour (AF). The value of the variable weight are in a range of -0.606 to 0.958. Because the variables in this group are associated with overall appearance of chili and garlic, this factor is defined as *chili and garlic*. This factor is the most important one due to its highest eigenvalue (9.327).

Factor 2 can explain variance of the original 30 variables with 15.31% and the best variables in this factor are coriander (A, F), dry chili, green chili (A), sweet (F) and color (AP). The values of the variable weight are in a range of 0.585 to 0.933. All variables that classified in this group are relevant to appearance and coriander characteristics; therefore this factor is defined as *appearance and coriander*. It is considered the second important factor as a result of its eigenvalue, which equaled to 4.593.

Factor 3 can explain variance of the original 30 variables with 14.67% and the best variables in this factor are red bean curd (A, F, AF), starchy (OT) and musty (A). The values of the variable weight are in a range of -0.623 to 0.798, which are related to texture and overall red bean curd. This factor can be defined as *texture and red bean curd*. It is the third important factor, and its eigenvalue is 4.401.

Factor 4 can explain variance of the original 30 variables with 12.50% and the best variables in this factor are pickled garlic (A, F, AF) and sour (F). The values of the variable weight are in a range of 0.556 to 0.862, related to overall pickled garlic. This factor is defined as *pickled garlic*, its eigenvalue is 3.750.

Factor 5 can explain variance of the original 30 variables with 9.49% and the best variables in this factor are umami (F, AF). The values of the variable weight are in a range of 0.847 to 0.920, which related to overall umami. This factor is defined as *umami*. The eigenvalue is 2.847.

Factor 6 can explain variance of the original 30 variables with 7.44% and the best variables in this factor are salty (F, AF). The values of the variable weight are in a range of 0.801 to 0.903. Since all variables are related to overall salty, then this factor can be defined as *salty*. This factor is important the least because its eigenvalue is the smallest (2.231) among all six factors.

In conclusion, FA technique classified all 30 sensory variables into six factors which can explain cumulative variance of 90.50%. These six factors are 1) chili and garlic factor 2) appearance and coriander factor 3) texture and red bean curd factor 4) pickled garlic factor 5) umami factor and 6) salty factor.

Table 2. Factor loading of rotated component matrix.

Variables	Factor and Factor loading of variables					
	1	2	3	4	5	6
Chili (A)	.958	-.082	-.040	-.151	-.125	.120
Chili (F)	.946	-.143	.043	-.141	-.159	.065
Garlic (A)	.939	.063	.025	.103	-.141	.095
Green chili (A)	.924	-.254	-.137	-.127	-.094	.066
Smooth (OT)	-.876	-.297	.051	.119	.177	-.243
Heat (AF)	.837	-.205	.336	-.274	-.108	.112
Chili/garlic (AP)	.829	.068	.124	-.364	-.241	.229
Heat (F)	.810	-.021	.404	-.285	-.212	.049
Sweet (AF)	-.685	.360	-.363	.253	-.253	-.143
Musty (F)	-.631	-.327	-.477	.079	.360	.180
Sour (AF)	-.606	-.049	-.248	.454	-.064	-.106
Coriander (A)	.188	.933	-.071	-.008	.086	-.054
Coriander (F)	.010	.929	-.144	.050	.208	.046
Dry chili (A)	-.085	.906	-.302	.090	.063	.090
Sweet (F)	-.373	.675	-.283	.125	.325	-.194
Color (AP)	-.385	.585	-.036	-.370	.546	-.021
Red bean curd (F)	.147	-.447	.798	-.204	.123	.137
Red bean curd (A)	-.133	-.378	.755	-.269	.068	.106
Viscosity (AP)	.375	-.163	.719	-.356	-.333	.186
Red bean curd (AF)	-.180	-.155	.702	.066	-.092	.508
Starchy (OT)	.317	-.414	.689	-.375	-.230	-.001
Musty (A)	-.545	-.210	-.623	.375	.222	.022
Pickled garlic (F)	-.238	.026	-.275	.862	.040	-.261
Sour (F)	-.112	.215	-.278	.803	-.134	-.199
Pickled garlic (AF)	-.337	-.024	-.064	.776	-.192	.075
Pickled garlic (A)	-.534	.020	-.392	.556	.327	-.213
Umami (AF)	-.215	.238	-.119	.016	.920	-.028
Umami (F)	-.272	.241	-.035	-.197	.847	.131
Salty (AF)	.244	-.004	.233	-.139	.070	.903
Salty (F)	.381	.026	.078	-.235	.032	.801
Eigenvalue	9.327	4.593	4.401	3.750	2.847	2.231
Variance explained (%)	31.09	15.31	14.67	12.50	9.49	7.44

$\sum = 90.50$

Note: Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Classification of physical, chemical and sensory characteristics

The relationship of instrumental parameters (physical and chemical) and six sensory factors were then conducted using PCA, the results is shown in Figure 4.

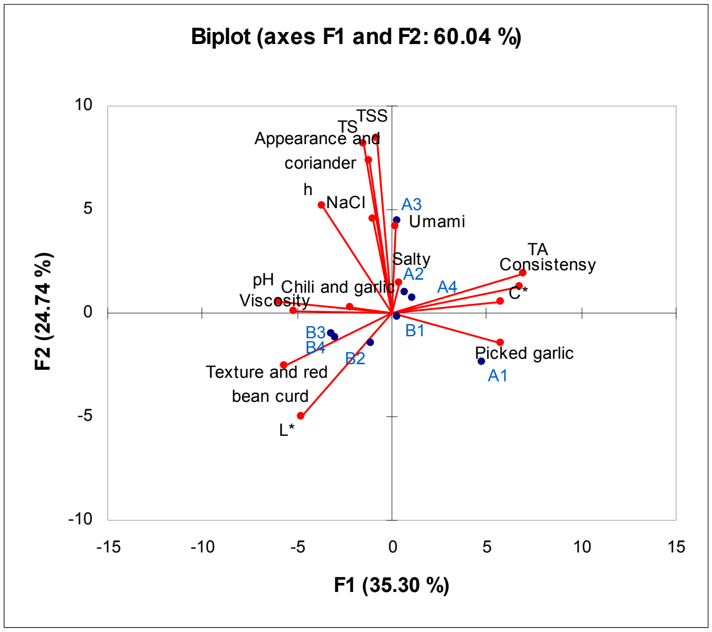

Figure 4. Relationship of instrumental parameters and descriptive sensory characteristics of eight Yentafo sauce evaluated by PCA.

The result showed that two main PCs having an explained total variance of 60.04%. The PC1 can explain 35.30% of the variation and positively related to C* value, consistency, total acidity and pickled garlic factor; which were contrary to L* value, viscosity, pH, chili/garlic factor and texture/red bean curd factor. The PC2 can explain 24.74% of the variation and positively related to h value, total soluble solid content, total solid content, salt content, appearance/coriander factor, umami factor and salty factor

Moreover, Yentafo sauce A1 related to pickled garlic factor, Yentafo sauce A2 and B1 related to salty factor, Yentafo sauce A3 related to h value, total soluble solid content, total solid content, salt content, appearance/coriander factor and umami factor, Yentafo sauce A4 related to C* value, consistency and total acidity and Yentafo sauce B2, B3 and B4 related to viscosity, pH, texture/red bean curd factor and chili/garlic factor.

Pearson correlation analysis indicated different relationship among instrumental parameter and sensory factors, the results are tabulated in Tabel 3. There are positive correlations between L* value and texture/red bean curd factor, h value and appearance and coriander factor, total acidity and pickled garlic factor, total soluble solid content/total solid content and appearance/coriander factor, and salt content and salty factor. While negative correlations are C* value and texture/read bean curd factor, consistency and texture/red bean curd factor, and pH and pickled garlic factor.

Table 3. The Pearson correlation matrix (r) among instrumental parameters and descriptive sensory characteristics.

Variables	Chili and garlic	Appearance and coriander	Texture and red bean curd	Picked garlic	Umami	Salty
L*	-0.024	-0.391	*0.785**	-0.488	-0.212	0.067
C*	-0.072	-0.352	*-0.718**	0.444	0.376	0.475
h	0.153	*0.723**	0.141	-0.575	0.218	-0.189
Viscosity	0.652	0.020	0.480	-0.375	-0.063	0.060
Consistensy	-0.370	0.003	*-0.823**	0.574	0.160	-0.081
TA	-0.449	0.089	-0.701	*0.758**	0.093	0.031
pH	-0.066	0.046	0.528	*-0.929**	0.374	-0.143
TSS	-0.053	*0.868**	-0.103	-0.183	0.434	0.128
TS	-0.026	*0.892**	0.002	-0.194	0.369	0.063
NaCl	0.420	0.242	-0.060	-0.226	0.280	*0.843**

*Significantly different (p≤0.05)

Conclusion

Eight Yentafo sauces, both from markets and laboratory prepared, were physical, chemical and sensory evaluated. Investigation of the relationship among instrumental parameter and sensory factors using PCA showed two main PCs having an explained total variance of 60.04%. The first component (PC1) explained 35.30% of the variation and positively related to C* value, consistency, total acidity and pickled garlic factor; but negatively related to L* value, viscosity, pH, chili/garlic factor and texture/red bean curd factor. The second component (PC2) explained 24.74% of the variation and positively related to h value, total soluble solid content, total solid content, salt content, appearance/coriander factor, umami factor and salty factor.

Pearson correlation analysis of the data indicated four groups of positive correlation between 1) L*value and texture/red bean curd factor 2) color value (h), total soluble solid content, total solid content and appearance/coriander factor 3) total acidity and pickled garlic factor and 4) salt content and salty factor. There were two groups of negative correlation between 1) pH and pickled garlic factor and 2) C*value/ consistency and texture/ red bean curd factor.

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