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Data article

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Abstract

This paper presents data on model cheeses extracted from the BaGaTel database. The data are issued from 6 different research projects in which data on composition, rheological and sensory properties were collected. The manufacturing of the 68 different samples is described. For each model cheese, data are available on final composition (lipid, protein, water, sodium), rheological properties (uniaxial compression), sensory profile analysis (texture, taste, aroma) and for some cheeses chewing activity and in vivo sodium release were also measured. The material and methods used are detailed. Scatter plots of representation of the values for each variable and each project are plotted. Pearson correlations between variables are given for specific subsets of data. The dataset is hosted in an open access data repository. This dataset will allow a comparison of sensory properties of cheeses varying in lipid, protein water and salt content and can be used for the reformulation of cheeses made with a low salt and fat content to follow food-related health recommendations, whilst fulfilling good sensory qualities.

Key Words: database, dairy food, quality, food structure, firmness, salty taste, fatty perception.

Specifications Table

Subject	Food science
Specific subject area	Dairy products, hard cheese and model cheese
Type of data	Microsoft excel Worksheet containing 10 sheets: 1) information on variables, 2) whole dataset, 3) missing data estimation, 4) dataset+estimated-data, 5) dataset_PCA-68samples, 6) correlation-matrices-68samples, 7) dataset_chewing-activity, 8) correlation-matrices_Chewing, 9) dataset_22samples-fatty, 10) correlation-matrix_22samples
How data were acquired	**Rheological data** were obtained with a TA XT2 texture analyzer (Stable, Micro Systems Ltd., Champlan, France). **Sensory analyses** were conducted in air-conditioned (21°C) sensory rooms, under red light and in individual booths. Sensory data acquisition was ensured with FIZZ software (Biosystems, Couternon, France). **Electromyographic signals** from the left and right superficial masseter and anterior temporalis muscles were recorded using gold surface electrodes (Grass Telefactor, West Warwick, RI, USA). **Sodium ion content** was analyzed by HPLC using a Dionex IonPac CS12-A column and an IonPac CG12-A guard column at 20 °C. System control and data acquisition were achieved using UCI-100 Chromeleon software (version 6.8).
Data format	Table in raw format (.xlsx)
Parameters for data collection	Different types of model cheeses are described, with their composition, manufacturing process, rheological and sensory properties and associated chewing behavior and in vivo sodium release.
Description of data collection	**The rheological properties** were determined by a uniaxial compression test at a constant displacement rate.

	Sensory profile analyses of texture, taste and aroma attributes were conducted with trained sensory panels. **Electromyography** (EMG) was used to evaluate the muscular activity during cheese chewing. **In vivo sodium release**: saliva samples were collected at different times during eating for sodium content analysis by HPLC.
Data source location	All data were collected and analyzed at INRAE-CSGA, 17 rue Sully, 21000 Dijon, France. All the data and metadata on the different projects have been imported in BaGaTel database (http://plasticnet.grignon.inra.fr/PortailBagatel/DefaultEN). Part of the data from projects Adi (Syarifuddin et al.,), Boisard (Boisard et al.,), Lawrence (Lawrence et al.,), Phan (Phan et al.,), Tarrega (Tarrega et al.,) have already been published. Syarifuddin. A.. et al.. *Reducing salt and fat while maintaining taste: An approach on a model food system.* Food Quality and Preference. 2016. **48**(Part A): p. 59-69. DOI: 10.1016/j.foodqual.2015.08.009. Boisard. L.. et al.. *Structure and composition of model cheeses influence sodium NMR mobility. kinetics of sodium release and sodium partition coefficients.* Food Chemistry. 2013. **136**(2): p. 1070-1077. DOI: 10.1016/j.foodchem.2012.09.035. Boisard. L.. et al.. *The salt and lipid composition of model cheeses modifies in-mouth flavour release and perception related to the free sodium ion content.* Food Chemistry. 2014a. **145**(2014): p. 437-444. DOI: 10.1016/j.foodchem.2013.08.049. Boisard. L.. et al.. *Salt and fat contents influence the microstructure of model cheeses. chewing/swallowing and in vivo aroma release.* Flavour and Fragrance Journal. 2014b. **29**(2): p. 95-106. DOI : 10.1002/ffj.3184. Lawrence. G.. et al.. *In vivo sodium release and saltiness perception in solid lipoprotein matrices. 1. Effect of composition and texture.* Journal of Agricultural and Food Chemistry. 2012a. **60**(21): p. 5287–5298. DOI: 10.1021/jf204434t. Lawrence. G.. et al.. *Using cross-modal interactions to counterbalance salt reduction in solid foods.* International Dairy Journal. 2011. **21**(2): p. 103-110. DOI: 10.1016/j.idairyj.2010.09.005. Lawrence. G.. et al.. *In vivo sodium release and saltiness perception in solid lipoprotein matrices. 2. Impact of oral parameters.* Journal of Agricultural and Food Chemistry. 2012b. **60**(21): p. 5299–5306. DOI: 10.1021/jf204435f. Phan. V.A.. et al.. *In vivo sodium release related to salty perception during eating model cheeses of different textures.* International Dairy Journal. 2008. **18**: p. 956-963. DOI: 10.1016/j.idairyj.2008.03.015. Tarrega. A.. et al.. *Effect of Oral Physiology Parameters on In-Mouth Aroma Compound Release Using Lipoprotein Matrices: An In Vitro Approach.* Foods. 2019. **8**(3). DOI: 10.3390/foods8030106.

	Tarrega. A.. et al.. *Aroma release and chewing activity during eating different model cheeses.* International Dairy Journal. 2008. **18**(8): p. 849-857. DOI: 10.1016/j.dairyj.2007.09.008. Tarrega. A.. et al.. *In-mouth aroma compound release during cheese consumption: Relationship with food bolus formation.* International Dairy Journal. 2011. **21**(5): p. 358-364. DOI: 10.1016/j.idairyj.2010.12.010.
Data accessibility	The raw data , provided as a Microsoft Excel file are available as a dataset [1] on the DataINRAE open access repository in BaGaTel dataverse (https://data.inra.fr/dataverse/bagatel; https://doi.org/10.15454/F40EXP)
Related research article	Elisabeth Guichard, Thierry Thomas-Danguin, Solange Buchin, Bruno Perret, Hervé Guillemin, Caroline Pénicaud, Christian Salles. **Relationships between cheese composition, rheological and sensory properties highlighted using the BaGaTel database.** International Dairy Journal, 2021, 118: 105039. https://doi.org/10.1016/j.idairyj.2021.105039. [2]

Value of the data

- **The dataset is a compilation of data from 6 different projects on a total of 68 model cheeses,**
- **This compilation allows to compare cheeses with a wider range of composition than in the individual projects, to generalize the effects observed in the individual projects and to find new relationships between the data**
- **The data can help scientists to link cheese composition, rheology and sensory properties and evaluate the impact of chewing activity**
- **The data can be compared with other sets of data obtained on different dairy products**
- **The data can be used for cheese reformulation following health recommendations (low salt and low fat content)**

1. Data description

The dataset gathered, for 68 cheese samples analyzed in six different projects (Adi, Boisard, Lawrence, Phan, PraSel, Tarrega), 5 blocks of data: cheese composition, rheological properties, sensory properties, chewing activity, in vivo sodium release.

The aim of the Adi project was to evaluate the effect of cross-modal interactions (odour-taste-texture) on salt and fat perception in cheese-like solid food products [3]. Eight model cheeses were prepared with 2 fat levels (80 and 160 g/kg), 2 levels of added NaCl (4.93 and 14.94 g/kg), the protein contents

varied from 204 to 310 g/kg and the water content was around 600 g/kg. Rheological and sensory analyses were performed.
The aim of the Boisard project was to understand the effects of model cheeses composition on mobility, release and perception of flavor molecules (salt, aroma compounds) [4-6]. Six model cheeses were prepared with 3 lipid/protein ratios, with lipid content from 200 to 280 g/kg and protein content from 170 to 240 g/kg, 2 levels of NaCl added (0 and 10 g/kg) and a water content around 464 g/kg. Rheological and sensory analyses were carried out, together with measurements of chewing activity and in vivo sodium release.
The aim of the Lawrence project was to determine to what extent the food composition influenced the sodium release and saltiness perception during cheese consumption [7-9]. Eighteen lipoprotein matrices were prepared with lipid content varying from 74 to 176 g/kg, protein content from 236 to 375 g/kg and 3 levels of added NaCl (5, 10 and 15g/kg). Rheological and sensory analyses were performed, together with measurements of chewing activity and in vivo sodium release.
The aim of the Phan project was to determine to what extent the ratios of fat/water, fat/protein or water/protein concentrations and texture influence the release of sodium, saltiness perception and chewing behavior during cheese consumption [10]. Four model cheeses were prepared, varying in lipid/dry matter (40 and 50%) content and matrix texture (2 different shear speed). Rheological and sensory analyses were carried out, together with measurements of chewing activity and in vivo sodium release.
The aim of the PraSel project was to characterize cheeses varying in salt content at the end of the maturation. Twenty four model hard cheeses were prepared with lipid content varying from 173 to 290 g/kg, protein content from 228 to 297 g/kg and added NaCl from 7 to 25 g/kg, with a water content varying from 419 to 542 g/kg. Rheological and sensory analyses were carried out.
The aim of the Tarrega project was to understand the effect of cheese composition and rheological properties on chewing behavior and aroma release as well as their relationships [11-13]. Eight model cheeses were prepared with 2 lipid/protein ratios with lipid content from 160 to 240 g/kg and protein content from 240 to 320 g/kg, 1 level of added NaCl (10 g/kg) and a water content around 479 g/kg. Rheological and sensory analyses were performed, together with chewing activity recording.

2. Experimental Design, Materials and Methods

2.1. Sample preparation

Sample preparation differed according to the projects.
In the Adi project [3], model cheeses were prepared by dissolving milk powder in warmed water (50 °C) using a blender (Waring, Torrington, CT, USA). The salt, native calcium phosphocaseinate (NCPP) and homogenized warmed anhydrous milk fat (AMF) were successively added and blended at high speeds for 2 min. Glucono-deltalactone was finally added to the mixture to adjust the pH value. The pH was monitored using a penetrometric electrode (Metrohm 781 pH/ion metre, Villebon-sur-Yvette, France) and adjusted to the target value (5.0 or 6.2). After a 3-h rest period for pH = 5.0 and immediately for pH = 6.2, rennet was added to the mixture, which was then vigorously mixed for 1 min. The mixture was immediately poured into plastic bags (Ecotel, Dijon, France) and then completely immersed in a

thermostatic bath at 33 °C for 1 h. The obtained model cheeses were stored at 4 °C until use for a maximum of 2 days.

In the Boisard project [4], batches of 500 g of model cheeses were prepared by mixing the ingredients in a cutter mixer (R3VV, Robot Coupe, Montceau-les-Mines, France) in the following order: water, NaCl, citric acid, rennet casein, acid casein, melting salts and milk fat, at 75 °C, with a mixing speed set at 2500 rpm for 7 min 30 s. The model cheeses were then placed in plastic cups and stored at -20 °C for 25 min, then vacuum-sealed and stored at 4 °C until use.

In the Lawrence project [7], lipoprotein matrices were developed by mixing pure water, anhydrous milk fat, skimmed milk powder, and sodium chloride vigorously for 12 min at room temperature using a blender (Waring, Torrington, CT, USA). The mixture was poured in a beaker and placed in a thermostatic bath at 32 °C. The pH was measured using a penetrometric electrode (Mettler-Toledo, France) and adjusted to a constant value of 6.2 or 6.5 by addition of glucono-deltalactone (GDL) or NaOH, respectively. After a rest period of 2 h (for a pH value of 6.2) or 30 min (for a pH value of 6.5), rennet (diluted 1/10 in pure water) was added and the preparation was mixed vigorously for 1 min. Prior to coagulation, the lipoprotein matrix was immediately poured into a plastic bag to form a roll, vacuum-sealed, and completely immersed in a thermostat controlled bath at 32 °C for 3 h. The products were stored at 4 °C until use for a maximum of 3 days.

In the Phan project [10], model cheeses were prepared using the processed cheese technology, with anhydrous milk fat (extra white with melting point 32 °C, Cormans, Goe-Limbourg, Belgium), rennet casein (Eurial Poitouraine, Nantes, France), melting salts (Kasomel 2185, Europhos, Engis, Belgium) and water in which flavor compounds were dissolved. Ingredients were mixed together at 85 °C for 6 min using a kneading machine (Stephan, Hameln, Germany). The model cheeses (cylinders of 10-cm diameter and 30-cm length) were cooled and kept at 4 °C under vacuum in thermally sealed plastic food grade bags. They were kept at least 10 days at 4 °C for stabilization, and then used for experimentation for 3 months after preparation date.

In the PraSel project, model hard cheeses were made by adding lactic ferments, calcium chloride and lysozyme to raw milk in a tank. After storage, 30 minutes at 32°C, and rennet addition, the curd was stirred 10 to 20 minutes at a temperature between 32 to 38°C, poured into moulds (10 kg per mould) and pressed. The curd was removed, cut in blocks of 2.5 kg, salted and stored in a cellar at 14°C between 47 and 69 days.

In the Tarrega project [12], model cheeses were prepared in 500 g batches using a cutter mixer (R3VV, Robot Coupe, Montceau en Bourgogne, France). The mixer was heated to 65 °C prior to use and the ingredients were added in the following order: water, acid and mineral solution, aroma solution, rennet casein, melting salt and fat. A constant mixing speed was applied for 7.5 min, during this time the temperature was kept at 65 °C. The prepared model cheeses were immediately poured into plastic bags and stored at -20 °C for 25 min, then vacuum-sealed and preserved at 4 °C for 2 weeks until use.

For a better visualization of the samples, Figure S1 shows the scatter plots of the samples composition for each project.

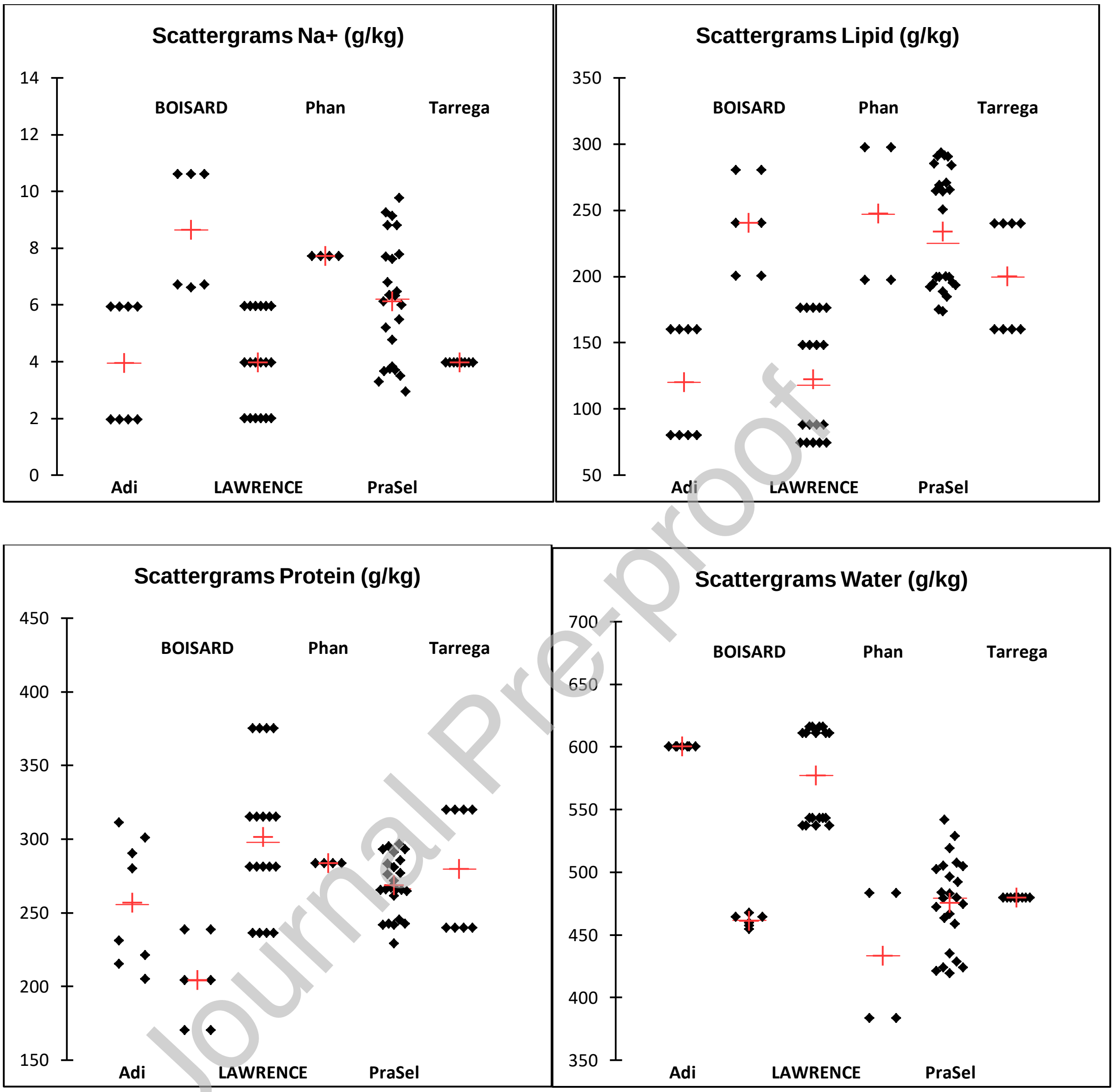

Figure S1: Scatter plots of the concentrations (mg/kg) in the different samples. top-left: Na+, top-right: lipid, bottom-left: protein and bottom-right: water. The crosses correspond to the means. The central horizontal bars are the medians.

2.2. Rheological properties

The rheological properties were determined by a uniaxial compression test using a Texture Analyser equipped with a cylindrical stainless steel probe (100-mm diameter compression platen attachment), at a constant displacement rate. The force developed by the cheese sample, which was equal to the resistance of the sample during compression, was measured with a load cell and recorded according to the position of the top plate. The Young modulus YM (kPa), the fracture stress FS (kPa), fracture strain CS (dimensionless), and the work at fracture WF (kJ m^{-3}) were calculated.

Differences in the methodology according to the projects are described below:

Adi: Rectangular pieces of the model cheese (3 cm height x 2 cm wide x 1 cm deep) were cut in the middle of the cheeses using a cork-borer, placed in a closed plastic tube and stored at 15 °C at least 15 min before the tests. Tests were performed at 15 °C at a constant displacement rate with a crosshead speed of 0.8 $mm.s^{-1}$ to a maximum deformation of 80%. Five replicates per sample were obtained.

Lawrence, PraSel: Cylindrical pieces of model cheeses (3 cm height x 1.1−1.5 cm diameter), were cut in the middle of the cheeses using a cork-borer, placed in a closed plastic tube and stored at 15 °C at least 15 min before the tests. Tests were performed at 15 °C at a constant displacement rate with a crosshead speed of 0.8 $mm.s^{-1}$ to a maximum deformation of 80%. Five replicates per sample were obtained.

Boisard: Cylindrical pieces of model cheeses (18 mm height x 13 mm diameter) were cut in the middle of the cheeses using a cork-borer, placed in a closed plastic tube and stored at 13 °C at least 15 min before the test. The samples were compressed with a 35-mm plate at a constant speed of 0.8 $mm.s^{-1}$ to a maximum deformation of 90%. Four replicates per sample were obtained.

Phan: Cylindrical pieces of model cheeses (2-cm length and a ratio length/diameter between 1.1 and 1.5) were cut, placed in a hermetically closed plastic tube and stored at 15 °C at least 15 min before the test. The displacement speed of the superior plate of the apparatus was 0.8 $mm.s^{-1}$. Samples were compressed until a maximum deformation of 85%. Five replicates per sample were obtained.

Tarrega: Cylindrical pieces of model cheeses (15 mm diameter x 25 mm height) were cut, placed in closed glass flasks and stored at 15 °C at least 15 min before the test. Tests were performed at 15 °C at a constant displacement rate with a crosshead speed of 0.8 $mm.s^{-1}$ to a maximum deformation of 80%. Four replicates per sample were obtained.

Figure S2 shows the scatter plots of the rheological properties of the samples for each project.

2.3. Sensory analyses

The sensory attributes of cheeses were evaluated by trained panels, using conventional sensory profiling and following a similar procedure. The panelists were provided with of 5 g cube of cheese, served at 13°C, and were asked to score texture, taste and aroma intensities on linear scales from 0 to 10 (0 = none and 10 = extremely strong). The samples were served in a random order, different for each panelist. The tests were conducted in an air-conditioned room (21°C), under red light in individual booths. Data acquisition was carried out with FIZZ software (Biosystèmes, Couternon, France). Between two samples, an interval of 90 s was allowed for the subjects to cleanse their mouth with apple, bread (salt-free), and mineral water. Before the test, panelists were requested not to smoke, eat or drink (except water) at least 1 h before the sensory session. The studies were performed in accordance with the relevant institutional and national regulations and legislation. Participants were requested to sign an informed consent form, but they were not informed of the aim of the experiment. The composition of the panel differed between the projects:

Adi: 21 panelists (11 women, 10 men; 20 to 61 years old).

Lawrence: 15 graduate students in food science (18 to 20 years old).

Boisard: 16 panelists (10 women, 6 men; 19 to 60 years old).

Phan: 17 panelists (12 women, 5 men; 25 to 65 years old).

PraSel: 14 panelists (mean of 20 years old).
Tarrega: 11 panelists (9 women, 2 men; 22 to 46 years old).

Figure S3 shows the scatter plots of the sensory properties of the samples for each project.

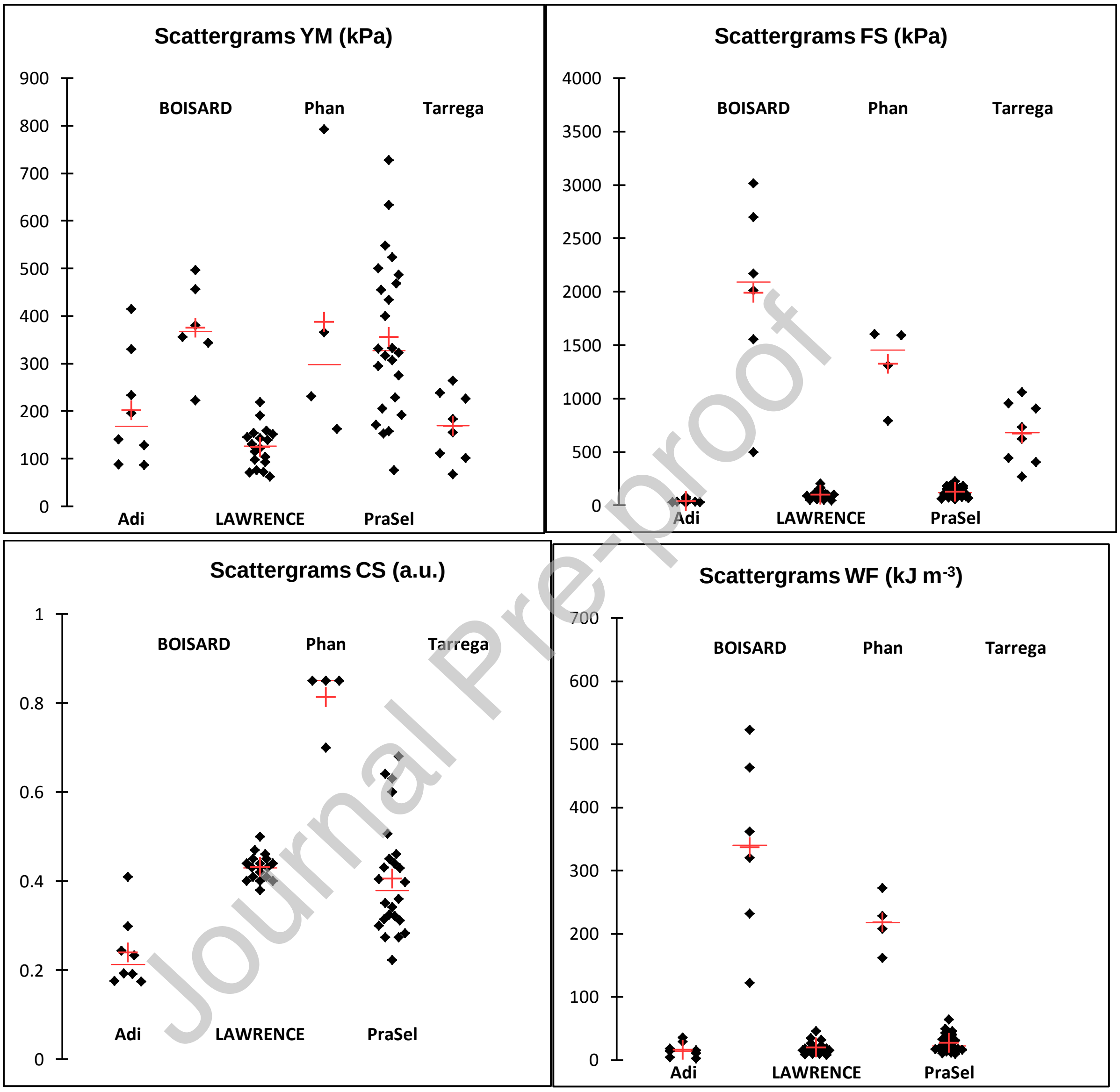

Figure S2: Scatter plots of the rheological properties. top-left: Young modulus YM (kPa), top-right: fracture stress FS (kPa), bottom-left: fracture strain CS (dimensionless), bottom-right: work at fracture WF (kJ m^{-3}). The crosses correspond to the means. The central horizontal bars are the medians.

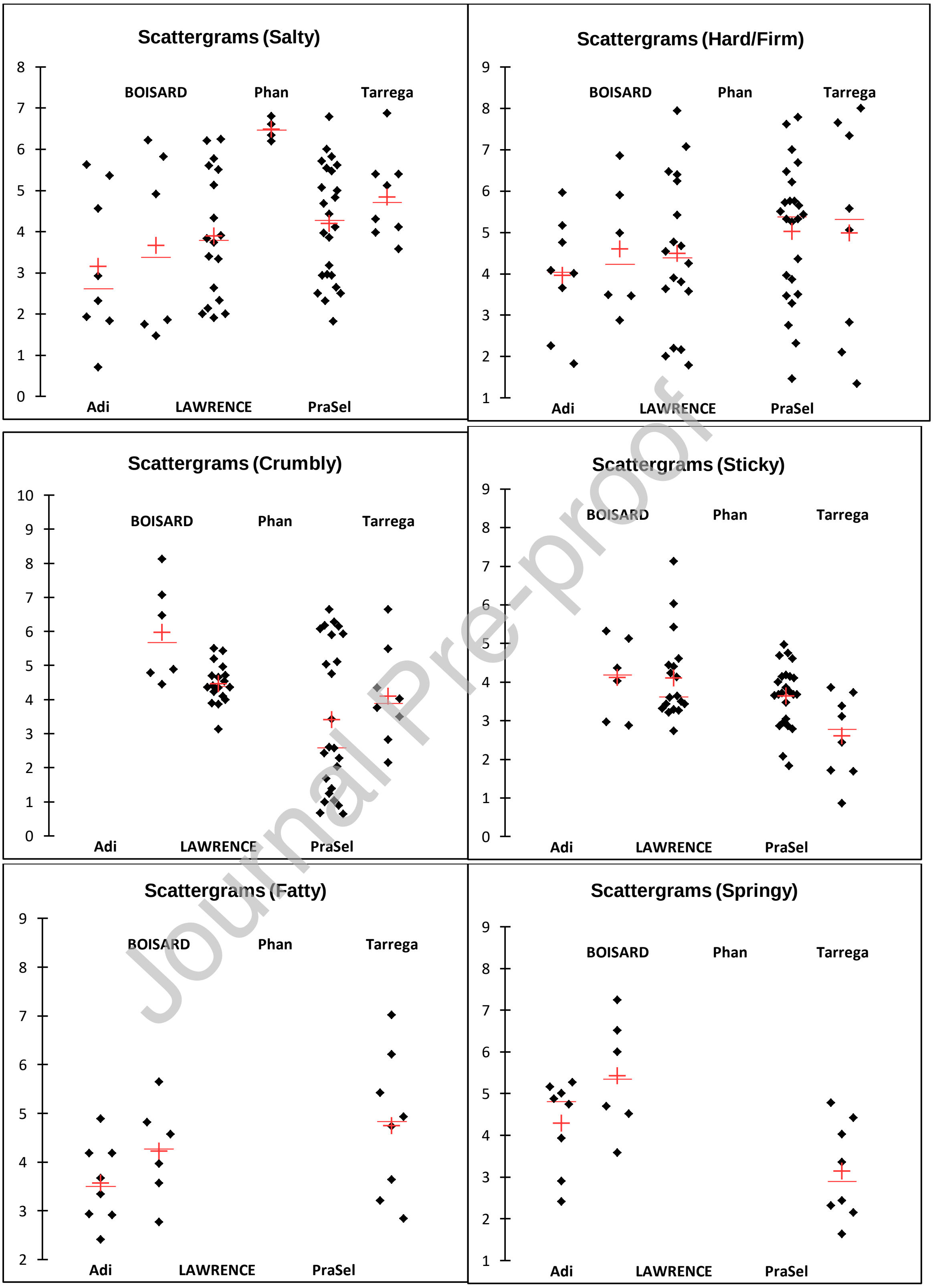

Figure S3: Scatter plots of the main sensory descriptors: salty, hard/firm, crumbly, sticky, fatty and springy. The crosses correspond to the means. The central horizontal bars are the medians.

2.4. Chewing behavior

Electromyography (EMG) was used to evaluate the muscular activity during chewing 5-g cube of cheese served at 13°C, without any constraint. Chewing duration (total sequence duration before the last swallow), number of chewing cycles during the chewing time, total muscular work (the sum of the integrated areas of all individual bursts in the sequence). The experiments were performed in triplicate.

The composition of the panel differed between the projects:

Boisard: 10 panelists (4 men, 6 women; 20 to 30 years old).

Lawrence: 5 panelists (2 men, 3 women; 23 to 46 years old).

Tarrega: 5 panelists (3 men, 2 women).

Phan: 17 panelists (12 women, 5 men; 25 to 65 years old).

Figure S4 shows the scatter plots of the chewing behavior parameters.

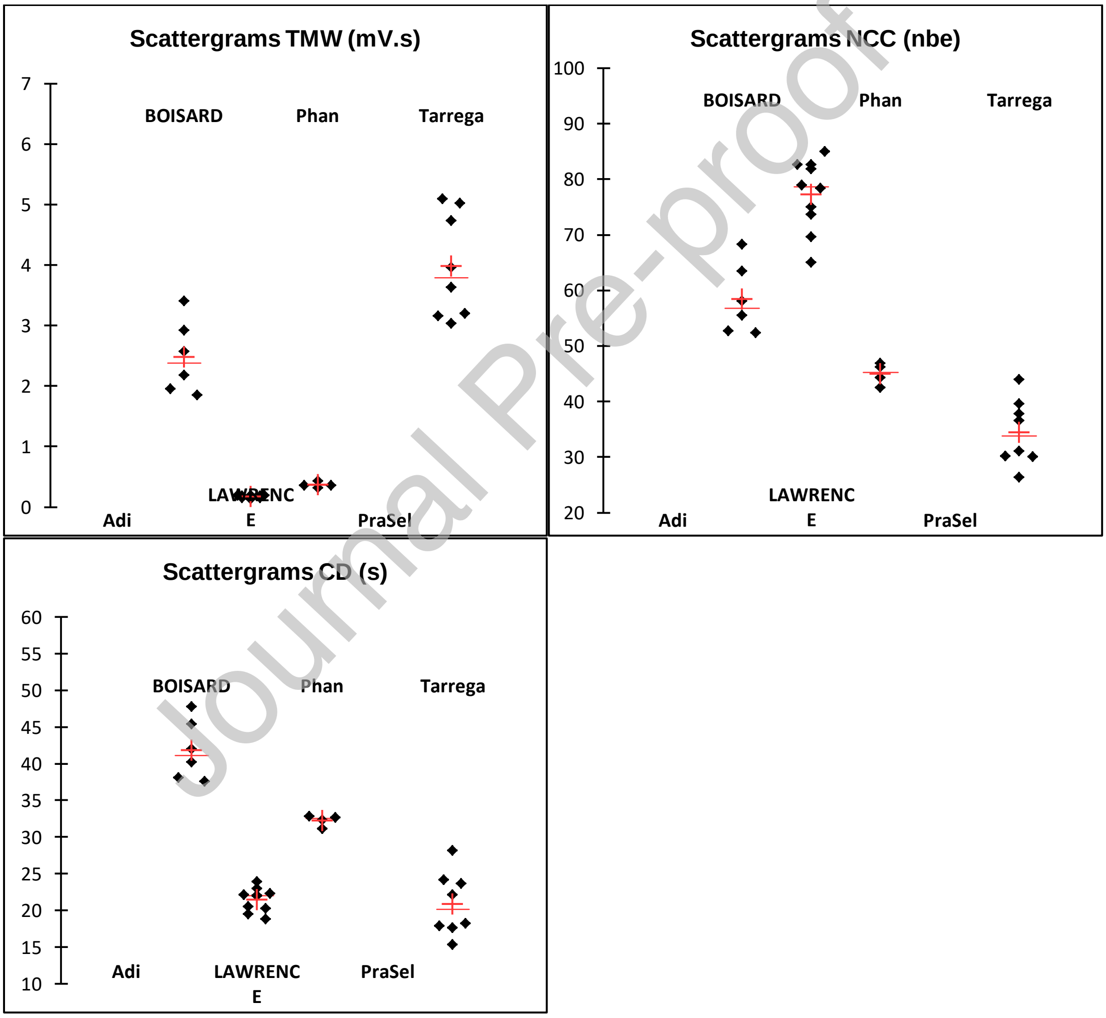

Figure S4: Scatter plots of the chewing parameters. TMW (mV.s): total muscular work (the sum of the integrated areas of all individual bursts in the sequence), NCC (nbe): number of chewing cycles during the chewing time, CD (s) Chewing duration (total sequence duration before the last swallow). The crosses correspond to the means. The central horizontal bars are the medians.

2.5. In vivo sodium release:

At different time points during the "normal" eating of a 5 g sample served at 13°C, the subjects were asked to spit out one saliva sample (around 0.5 mL) into a 5 mL plastic tube, 13 mm in diameter (Camlab Ltd., Cambridge, U.K.). Saliva samples were immediately put in an ice bath and centrifuged at 28600 g for 5 min at 4 °C. The supernatants were stored at −20 °C until HPLC analysis. Elution was achieved in isocratic mode with 22 mN sulfuric acid (Sigma-Aldrich, France) at a flow rate of 0.5 mL/min. Quantification of sodium ions content was performed using sodium standard solutions ranging from 0 to 30 mg Na/L prepared in 22 mN sulfuric acid. The experiments were performed in triplicate. The composition of the panel differed between the projects:

Boisard: 5 panelists (3 men, 2 women; 29 to 61 years old)

Lawrence: 5 panelists (2 men, 3 women; 23 to 46 years old)

Phan: 17 panelists (12 women, 5 men; 25 to 65 years old).

Figure S5 shows the scatter plots of the in vivo sodium release measurement.

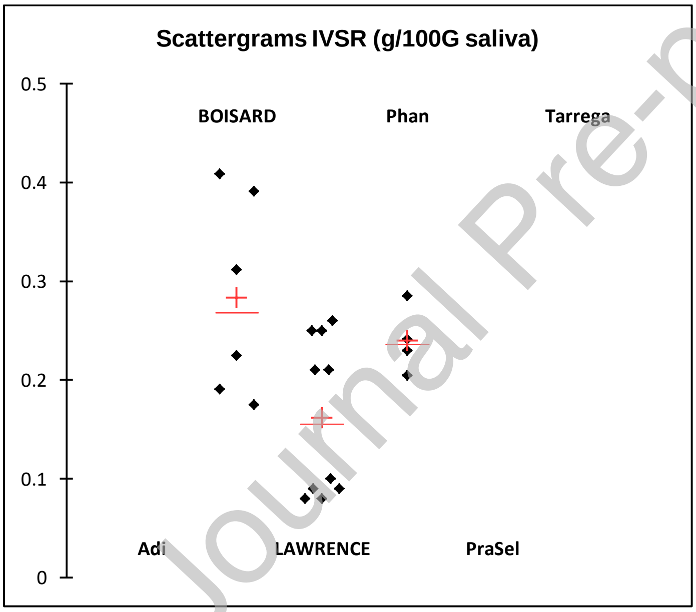

Figure S5: Scatter plots of the amount of in vivo sodium released in saliva (IVSR: g/100g saliva). The crosses correspond to the means. The central horizontal bars are the medians.

3. Correlations between the measured variables

For further statistical analyses presented in the paper submitted to International Journal of Dairy Science [2], different subsets of data have been identified in the dataset [1] and the matrices of Pearson correlation are presented below (Supplementary Tables S1 to S6), together with plots of some significant correlations (Figures S6 and S7).

Table S1: matrix of Pearson correlations from PCA on 68 samples (projects Adi, Boisard, Lawrence, PraSel, Tarrega, Phan), in bold: values significant at 95%.

Variables	Na+	Lipid	Protein	Water	Lipid/DM	Na+/water	MNFS	YM	FS	Salty	Hard/Firm
Na+	**1**	**0.391**	**-0.264**	**-0.463**	**0.245**	**0.972**	**-0.363**	**0.540**	**0.394**	**0.672**	**0.193**
Lipid	**0.391**	**1**	**-0.584**	**-0.843**	**0.861**	**0.537**	**-0.319**	**0.367**	**0.238**	**0.167**	**0.028**
Protein	**-0.264**	**-0.584**	**1**	**0.152**	**-0.804**	**-0.274**	**-0.414**	**-0.019**	**-0.229**	**0.015**	**0.542**
Water	**-0.463**	**-0.843**	**0.152**	**1**	**-0.509**	**-0.632**	**0.777**	**-0.524**	**-0.422**	**-0.238**	**-0.424**
Lipid/DM	**0.245**	**0.861**	**-0.804**	**-0.509**	**1**	**0.334**	**0.110**	**0.192**	**0.074**	**0.041**	**-0.231**
Na+/water	**0.972**	**0.537**	**-0.274**	**-0.632**	**0.334**	**1**	**-0.495**	**0.603**	**0.453**	**0.626**	**0.274**
MNFS	**-0.363**	**-0.319**	**-0.414**	**0.777**	**0.110**	**-0.495**	**1**	**-0.506**	**-0.469**	**-0.231**	**-0.723**
YM	**0.540**	**0.367**	**-0.019**	**-0.524**	**0.192**	**0.603**	**-0.506**	**1**	**0.259**	**0.173**	**0.629**
FS	**0.394**	**0.238**	**-0.229**	**-0.422**	**0.074**	**0.453**	**-0.469**	**0.259**	**1**	**0.038**	**0.282**
Salty	**0.672**	**0.167**	**0.015**	**-0.238**	**0.041**	**0.626**	**-0.231**	**0.173**	**0.038**	**1**	**0.048**
Hard/Firm	**0.193**	**0.028**	**0.542**	**-0.424**	**-0.231**	**0.274**	**-0.723**	**0.629**	**0.282**	**0.048**	**1**

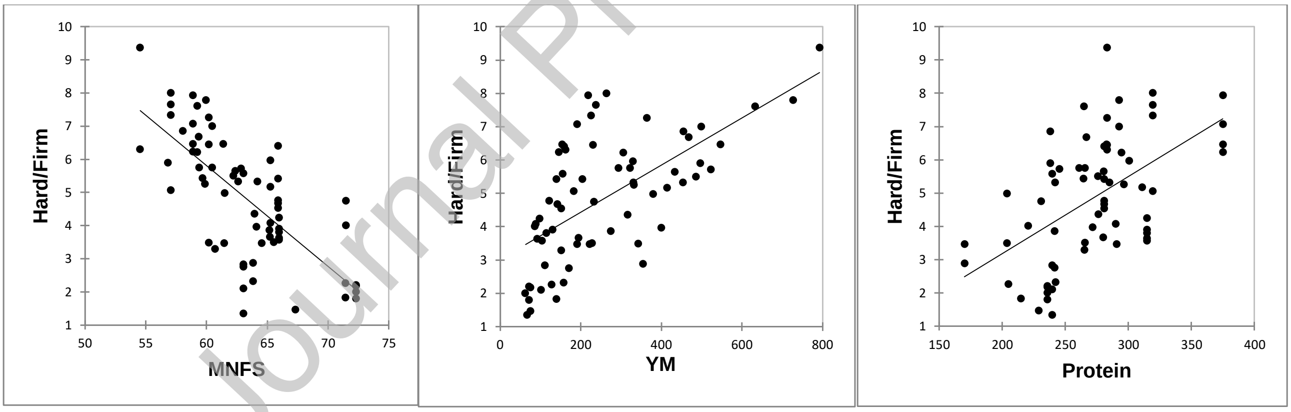

Figure S6: Representation of the relationships between hard/firm and MNFS (Moisture-in-non-fat), YM (Young's modulus), Protein.

Table S2: matrix of Pearson correlations from PCA on 32 samples with a sodium ions content below 5g/kg (projects Adi, Lawrence, PraSel, Tarrega), in bold: values significant at 95%.

Variables	Na+	Lipid	Protein	Water	Lipid/DM	Na+/water	MNFS	YM	FS	Salty	Hard/Firm
Na+	**1**	**0.349**	**-0.021**	**-0.487**	**0.095**	**0.953**	**-0.382**	-0.010	**0.395**	**0.692**	**-0.049**
Lipid	**0.349**	**1**	**-0.641**	**-0.787**	**0.869**	**0.542**	**-0.128**	**0.074**	**0.131**	**0.271**	**-0.258**
Protein	**-0.021**	**-0.641**	**1**	**0.073**	**-0.865**	**-0.056**	**-0.609**	**0.261**	**0.248**	**-0.098**	**0.717**
Water	**-0.487**	**-0.787**	**0.073**	**1**	**-0.452**	**-0.722**	**0.712**	**-0.288**	**-0.529**	**-0.398**	**-0.220**
Lipid/DM	**0.095**	**0.869**	**-0.865**	**-0.452**	**1**	**0.233**	**0.265**	**0.025**	**-0.087**	**0.067**	**-0.426**
Na+/water	**0.953**	**0.542**	**-0.056**	**-0.722**	**0.233**	**1**	**-0.543**	**0.081**	**0.513**	**0.693**	**0.019**
MNFS	**-0.382**	**-0.128**	**-0.609**	**0.712**	**0.265**	**-0.543**	**1**	**-0.379**	**-0.701**	**-0.333**	**-0.641**
YM	-0.010	**0.074**	**0.261**	**-0.288**	**0.025**	**0.081**	**-0.379**	**1**	**0.146**	**-0.292**	**0.545**
FS	**0.395**	**0.131**	**0.248**	**-0.529**	**-0.087**	**0.513**	**-0.701**	**0.146**	**1**	**0.493**	**0.507**
Salty	**0.692**	**0.271**	**-0.098**	**-0.398**	**0.067**	**0.693**	**-0.333**	**-0.292**	**0.493**	**1**	**-0.211**
Hard/Firm	**-0.049**	**-0.258**	**0.717**	**-0.220**	**-0.426**	**0.019**	**-0.641**	**0.545**	**0.507**	**-0.211**	**1**

Table S3: matrix of Pearson correlations from PCA on 36 samples with a sodium ions content higher than 5g/kg (projects Adi, Boisard, Lawrence, Phan, PraSel), in bold: values significant at 95%.

Variables	Na+	Lipid	Protein	Water	Lipid/DM	Na+/water	MNFS	YM	FS	Salty	Hard/Firm
Na+	**1**	**0.310**	**-0.254**	**-0.407**	**0.159**	**0.925**	**-0.367**	**0.403**	**0.354**	**0.417**	**0.116**
Lipid	**0.310**	**1**	**-0.500**	**-0.864**	**0.848**	**0.588**	**-0.405**	**0.388**	**0.221**	**-0.141**	**0.175**
Protein	**-0.254**	**-0.500**	**1**	**0.120**	**-0.741**	**-0.250**	**-0.368**	**0.024**	**-0.332**	**0.316**	**0.514**
Water	**-0.407**	**-0.864**	**0.120**	**1**	**-0.511**	**-0.710**	**0.809**	**-0.551**	**-0.373**	**0.088**	**-0.533**
Lipid/DM	**0.159**	**0.848**	**-0.741**	**-0.511**	**1**	**0.337**	**0.056**	**0.164**	**0.067**	**-0.218**	**-0.137**
Na+/water	**0.925**	**0.588**	**-0.250**	**-0.710**	**0.337**	**1**	**-0.602**	**0.514**	**0.423**	**0.310**	**0.298**
MNFS	**-0.367**	**-0.405**	**-0.368**	**0.809**	**0.056**	**-0.602**	**1**	**-0.550**	**-0.419**	**-0.018**	**-0.774**
YM	**0.403**	**0.388**	**0.024**	**-0.551**	**0.164**	**0.514**	**-0.550**	**1**	**0.173**	**-0.025**	**0.709**
FS	**0.354**	**0.221**	**-0.332**	**-0.373**	**0.067**	**0.423**	**-0.419**	**0.173**	**1**	**-0.281**	**0.199**
Salty	**0.417**	**-0.141**	**0.316**	**0.088**	**-0.218**	**0.310**	**-0.018**	**-0.025**	**-0.281**	**1**	**0.046**
Hard/Firm	**0.116**	**0.175**	**0.514**	**-0.533**	**-0.137**	**0.298**	**-0.774**	**0.709**	**0.199**	**0.046**	**1**

Table S4: matrix of Pearson correlations from PCA on 13 samples with a low sodium ions content and data on chewing behavior (projects Lawrence, Tarrega), in bold: values significant at 95%.

Variables	Na+	Lipid	Protein	Water	Lipid/DM	Na+/water	MNFS	YM	FS	Salty	Hard/Firm	TMW	NCC	CD
Na+	**1**	**0.723**	**-0.274**	**-0.916**	**0.554**	**0.998**	**-0.621**	**0.273**	**0.791**	**0.863**	0.015	**0.947**	**-0.959**	**-0.103**
Lipid	**0.723**	**1**	**-0.768**	**-0.719**	**0.966**	**0.730**	**-0.059**	**-0.202**	**0.282**	**0.774**	**-0.360**	**0.531**	**-0.785**	**-0.385**
Protein	**-0.274**	**-0.768**	**1**	**0.125**	**-0.884**	**-0.256**	**-0.564**	**0.695**	**0.215**	**-0.448**	**0.751**	**-0.050**	**0.441**	**0.558**
Water	**-0.916**	**-0.719**	**0.125**	**1**	**-0.529**	**-0.937**	**0.736**	**-0.436**	**-0.758**	**-0.783**	**-0.218**	**-0.870**	**0.836**	0.005
Lipid/DM	**0.554**	**0.966**	**-0.884**	**-0.529**	**1**	**0.556**	**0.182**	**-0.361**	**0.101**	**0.646**	**-0.481**	**0.351**	**-0.662**	**-0.451**
Na+/water	**0.998**	**0.730**	**-0.256**	**-0.937**	**0.556**	**1**	**-0.643**	**0.299**	**0.794**	**0.861**	**0.044**	**0.945**	**-0.951**	**-0.090**
MNFS	**-0.621**	**-0.059**	**-0.564**	**0.736**	**0.182**	**-0.643**	**1**	**-0.818**	**-0.823**	**-0.379**	**-0.657**	**-0.742**	**0.444**	**-0.366**
YM	**0.273**	**-0.202**	**0.695**	**-0.436**	**-0.361**	**0.299**	**-0.818**	**1**	**0.758**	**-0.118**	**0.945**	**0.518**	**-0.050**	**0.195**
FS	**0.791**	**0.282**	**0.215**	**-0.758**	**0.101**	**0.794**	**-0.823**	**0.758**	**1**	**0.425**	**0.559**	**0.939**	**-0.641**	0.002
Salty	**0.863**	**0.774**	**-0.448**	**-0.783**	**0.646**	**0.861**	**-0.379**	**-0.118**	**0.425**	**1**	**-0.373**	**0.695**	**-0.906**	**0.045**
Hard/Firm	0.015	**-0.360**	**0.751**	**-0.218**	**-0.481**	**0.044**	**-0.657**	**0.945**	**0.559**	**-0.373**	**1**	**0.275**	**0.211**	**0.170**
TMW	**0.947**	**0.531**	**-0.050**	**-0.870**	**0.351**	**0.945**	**-0.742**	**0.518**	**0.939**	**0.695**	**0.275**	**1**	**-0.851**	**-0.043**
NCC	**-0.959**	**-0.785**	**0.441**	**0.836**	**-0.662**	**-0.951**	**0.444**	**-0.050**	**-0.641**	**-0.906**	**0.211**	**-0.851**	**1**	**0.109**
CD	**-0.103**	**-0.385**	**0.558**	0.005	**-0.451**	**-0.090**	**-0.366**	**0.195**	0.002	**0.045**	**0.170**	**-0.043**	**0.109**	**1**

Table S5: matrix of Pearson correlations from PCA on 15 samples with a high sodium ions content and data on chewing behavior (projects Boisard, Lawrence, Phan). in bold: values significant at 95%.

Variables	Na+	Lipid	Protein	Water	Lipid/DM	Na+/water	MNFS	YM	FS	Salty	Hard/Firm	TMW	NCC	CD
Na+	1	0.526	-0.514	-0.536	0.476	0.939	-0.315	0.472	0.443	0.234	-0.070	0.483	-0.498	0.618
Lipid	0.526	1	-0.698	-0.846	0.959	0.720	-0.322	0.556	0.449	-0.096	0.110	0.395	-0.790	0.646
Protein	-0.514	-0.698	1	0.326	-0.821	-0.486	-0.266	-0.277	-0.480	0.382	0.488	-0.672	0.421	-0.670
Water	-0.536	-0.846	0.326	1	-0.671	-0.782	0.775	-0.694	-0.566	0.072	-0.529	-0.390	0.752	-0.690
Lipid/DM	0.476	0.959	-0.821	-0.671	1	0.612	-0.056	0.431	0.387	-0.119	-0.103	0.388	-0.704	0.586
Na+/water	0.939	0.720	-0.486	-0.782	0.612	1	-0.533	0.617	0.504	0.194	0.153	0.466	-0.656	0.685
MNFS	-0.315	-0.322	-0.266	0.775	-0.056	-0.533	1	-0.582	-0.455	-0.023	-0.822	-0.192	0.410	-0.435
YM	0.472	0.556	-0.277	-0.694	0.431	0.617	-0.582	1	0.510	-0.086	0.585	0.444	-0.515	0.622
FS	0.443	0.449	-0.480	-0.566	0.387	0.504	-0.455	0.510	1	-0.544	0.251	0.818	-0.419	0.914
Salty	0.234	-0.096	0.382	0.072	-0.119	0.194	-0.023	-0.086	-0.544	1	0.095	-0.706	-0.148	-0.527
Hard/Firm	-0.070	0.110	0.488	-0.529	-0.103	0.153	-0.822	0.585	0.251	0.095	1	-0.112	-0.315	0.141
TMW	0.483	0.395	-0.672	-0.390	0.388	0.466	-0.192	0.444	0.818	-0.706	-0.112	1	-0.121	0.910
NCC	-0.498	-0.790	0.421	0.752	-0.704	-0.656	0.410	-0.515	-0.419	-0.148	-0.315	-0.121	1	-0.478
CD	0.618	0.646	-0.670	-0.690	0.586	0.685	-0.435	0.622	0.914	-0.527	0.141	0.910	-0.478	1

Tables S6: matrix of Pearson correlations from PCA on 22 samples with data on fatty perception (projects Adi, Boisard, Tarrega), in bold: values significant at 95%.

Variables	Na+	Lipid	Protein	Water	Lipid/DM	Na+/water	MNFS	YM	FS	Salty	Hard/Firm	Crumbly	Sticky	Fatty	Springy
Na+	**1**	**0.460**	**-0.503**	**-0.465**	**0.183**	**0.984**	**-0.273**	**0.540**	**0.587**	**0.358**	**-0.030**	**0.182**	**0.372**	**0.140**	**0.328**
Lipid	**0.460**	**1**	**-0.697**	**-0.770**	**0.669**	**0.553**	**-0.200**	**0.026**	**0.445**	**0.232**	**-0.300**	**-0.377**	**0.299**	**0.578**	**0.091**
Protein	**-0.503**	**-0.697**	**1**	**0.163**	**-0.870**	**-0.501**	**-0.429**	-0.012	**-0.205**	**0.052**	**0.620**	**0.203**	**-0.740**	**-0.353**	**-0.344**
Water	**-0.465**	**-0.770**	**0.163**	**1**	**-0.073**	**-0.592**	**0.778**	**-0.292**	**-0.701**	**-0.311**	**-0.204**	**0.092**	**0.157**	**-0.373**	-0.013
Lipid/DM	**0.183**	**0.669**	**-0.870**	**-0.073**	**1**	**0.185**	**0.546**	**-0.275**	**-0.041**	**-0.034**	**-0.607**	**-0.448**	**0.479**	**0.367**	**0.054**
Na+/water	**0.984**	**0.553**	**-0.501**	**-0.592**	**0.185**	**1**	**-0.375**	**0.573**	**0.667**	**0.348**	0.000	**0.175**	**0.328**	**0.179**	**0.322**
MNFS	**-0.273**	**-0.200**	**-0.429**	**0.778**	**0.546**	**-0.375**	**1**	**-0.434**	**-0.650**	**-0.250**	**-0.606**	**-0.238**	**0.529**	-0.002	**0.053**
YM	**0.540**	**0.026**	-0.012	**-0.292**	**-0.275**	**0.573**	**-0.434**	**1**	**0.686**	**-0.177**	**0.503**	**0.698**	0.000	**-0.309**	**0.465**
FS	**0.587**	**0.445**	**-0.205**	**-0.701**	**-0.041**	**0.667**	**-0.650**	**0.686**	**1**	**-0.133**	**0.402**	**0.451**	**-0.117**	**-0.157**	**0.464**
Salty	**0.358**	**0.232**	**0.052**	**-0.311**	**-0.034**	**0.348**	**-0.250**	**-0.177**	**-0.133**	**1**	**-0.220**	**-0.348**	**0.027**	**0.613**	**-0.260**
Hard/Firm	**-0.030**	**-0.300**	**0.620**	**-0.204**	**-0.607**	0.000	**-0.606**	**0.503**	**0.402**	**-0.220**	**1**	**0.344**	**-0.702**	**-0.651**	0.009
Crumbly	**0.182**	**-0.377**	**0.203**	**0.092**	**-0.448**	**0.175**	**-0.238**	**0.698**	**0.451**	**-0.348**	**0.344**	**1**	**-0.053**	**-0.467**	**0.432**
Sticky	**0.372**	**0.299**	**-0.740**	**0.157**	**0.479**	**0.328**	**0.529**	0.000	**-0.117**	**0.027**	**-0.702**	**-0.053**	**1**	**0.380**	**0.392**
Fatty	**0.140**	**0.578**	**-0.353**	**-0.373**	**0.367**	**0.179**	-0.002	**-0.309**	**-0.157**	**0.613**	**-0.651**	**-0.467**	**0.380**	**1**	**-0.195**
Springy	**0.328**	**0.091**	**-0.344**	-0.013	**0.054**	**0.322**	**0.053**	**0.465**	**0.464**	**-0.260**	0.009	**0.432**	**0.392**	**-0.195**	**1**

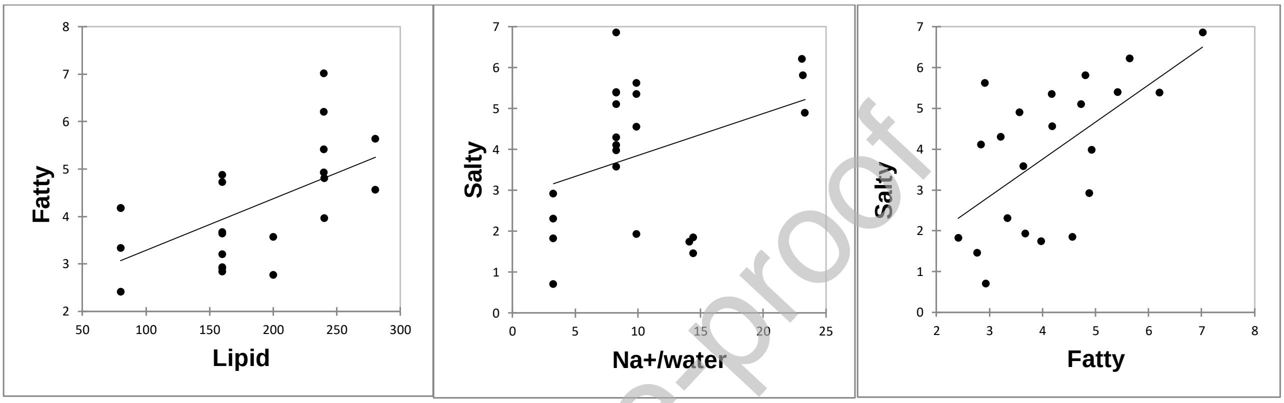

Figure S7: Representation of the relationships between fatty and lipid, salty and Na+/water, salty and fatty.

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Ethics Statement

Not applicable.

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