AgroStat

Marseille, 14-16 March 2018

Due to the increasing quantity of data in agrosciences, there is a need for specific tools which place statistics and data science at the heart of challenges of the contemporary world. The AGROSTAT conference gives statisticians, engineers and users of statistical methods a unique opportunity to exchange around topics, such as sensometrics, chemometrics, experimental designs, risk analysis, process control or big data.

This event brings together internationally recognized academic and industrial organizations representatives, to take stock of advances in statistics, express their needs and to anticipate future challenges.

This conference, which is held every two years, is organized this year by **Aix-Marseille University,** the "Mediterranean Institute of Biodiversity and Marine and Continental Ecology", UMR CNRS 7263 / IRD 237, team Toxicology & Environmental Health (TSE), under the auspices of the Agro-Industry Group of the French Statistical Society (SFdS). The SFdS is a non-profit organization bringing together researchers, engineers, teachers and statistics users.

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Wednesday 14 March

9h00			**Welcome speech - M. SERGENT, M. QANNARI**
			Inaugural conference
9h15	**PL1**	**B. K. Ersbøll**	**Big Data from Farm to Fork, advantages and challenges**
			Session 1: BIG DATA/MACHINE LEARNING/DEEP LEARNING - Chair: S. Marque
10h20	**O01**	P. Rebenaque	Automated analysis of tasting comments in sensory analysis
10h40	**O02**	M.-B Blanquart	Impact of the questionnaire structure on overall results in preference mapping: a meta-analysis on 285 consumer studies
11h00	**O03**	S. Bougeard	Current multiblock methods: competition or complementarity? A comparative study in a unified framework
11h20			***Coffee break***
			Session 2: DEVELOPMENT TOOLS - Chair: D. Brémaud
11h50	**O04**	N. Pineau	Use of R-Shiny apps to communicate sensory and consumer modeling tools outputs
12h10	**O05**	I. Rebhi	An interactive shiny tool for sensory and consumer data mapping : sensmapui
12h30			***Lunch***
			Session 3: CHEMOMETRICS - Chairs: D. Rutledge/ E. Vigneau
14h00	**PL2**	**P. Bastien**	**Use of sparse methods in cosmetics**
15h00	**O06**	B. Jaillais	Random forests for the prediction of water content by near-infrared hyperspectral imaging spectroscopy in biscuits
15h20	**OO7**	C. Peltier	What is the better test to detect multivariate differences in large dimensional data?
15h40	**O08**	D.N. Rutledge	Comparison of Principal Components Analysis, Independent Components Analysis and Common Components Analysis
16h00			***Coffee break***
16h30	**O09**	E. Vigneau	Analyse des relations entre plusieurs blocs de données par l'approche Path-Comdim: une application pour évaluer la qualité environnementale sur le littoral atlantique français
16h50			**Poster presentations**
17h15			POSTER SESSION
18h00			***Welcome Reception: Les Halles de la Major***

Thurs day 15 March

Session 4: SENSOMETRICS - Chairs : Ph. Courcoux / P. Schlich			
8h45	**PL3**	**J. Castura**	**Consumer diversity in sensory evaluation data**
9h30	**O10**	M. Brard	A latent class regression model for the clustering of multivariate binary ratings
9h50	**O11**	E. Qannari	One thousand and one ways to analyze free sorting data
10h10	**O12**	N. Pineau	CATA as an alternative method to free sorting
10h30			***Coffee break***
11h00	**O13**	F. Llobell	Clustatis: a cluster analysis of multiblock datasets. application to sensometrics
11h20	**O14**	G. Lecuelle	Modeling temporal dominance of sensations data with stochastic processes
11h40	**PL4**	**B. Boulanger**	**Round table: The world beyond p-values: how to make research in the 21st?**
12h30			***Lunch & posters***
14h30			***SOCIAL EVENT***
19h30			***Gala diner : Reverso - Les Terrasses du port***

Friday 16 March

Session 5: EXPERIMENTAL DESIGNS - Chairs: M. Claeys/M. Sergent

9h00	**PL5**	**J-P Gauchi**	**Metamodeling and global sensitivity analysis for computer models with correlated input**
9h45	**O15**	S. Marque	Plan d'expériences et simulations sur le contrôle qualité des contaminants microbiologiques de produits finaux
10h05	**O16**	Q. Carboué	Experimental design and solid state fermentation: a holistic approach to improve cultural medium for the production of fungal metabolites
10h25			***Coffee break***
10h55	**O17**	V. Rodrigues	Food source attribution of human campylobacteriosis by meta-analysis of case-control studies
11h15	**O18**	U. Gonzales-Barron	An extended bigelow-type meta-regression model describing the heat resistance of neosartorya spores
11h35	**O19**	V. Cadavez	Dynamic determination of optimum growth rate of listeria monocytogenes in minas soft cheese during cold shelf-life
11h55		P. Schlich	Statistical analysis of chocolate tasting data obtained from participants
12h15			***Closing of the conference, Awards*** ***Lunch***

TEXTURAL QUALITY ATTRIBUTES OF GLUTEN-FREE BATTER AND BREAD AS AFFECTED BY HYDROCOLLOIDS

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Abstract

This study aimed to compare the separate effects of xanthan gum (XG), guar gum (GG) and hydroxyl-propyl methyl-cellulose (HPMC) on gluten-free batter and bread quality; and to explore the interrelationships among 24 measurements of physicochemical and rheological attributes of batter and bread. Twenty-seven formulations were produced with 1.5, 2.5, 3.5% XG and 90, 100, 110% water (9 combinations); 2.5, 3.0, 3.5% GG and 90, 100, 110% water (9 combinations); and 3.0, 4.0, 5.0% of HPMC and 80, 90, 100% water (9 combinations). A principal component analysis revealed that the information contained in the 24 variables could be effectively decomposed into two major components, one related to bread crumb porosity and hardness (45%), and the other to batter viscosity (32%). XG and GG produced gluten-free batter and bread of similar quality, although GG, particularly at high dose, can produce smaller loaves of harder and more resilient and cohesive crumb than XG. Compared to XG and GG, HPMC yielded batters of higher stickiness, consistency and firmness, which, when baked, produced loaves of higher volume, softer crumb, and larger pores.

Keywords: Principal component analysis, gum, xanthan, guar, HPMC, rheology, texture

INTRODUCTION

In order to improve the rheological properties of gluten-free bread, hydrocolloids or gums are added to the batter as these molecules are able to imitate the viscoelastic properties of gluten. Xanthan gum (XG), a polysaccharide obtained from a fermentation process of *Xanthomonas campestris*, and guar gum (GG), a polysaccharide derived from guar beans, have the ability to thicken the batter and improve the elasticity of the crumb. Another hydrocolloid, hydroxyl-propyl methyl-cellulose (HPMC) is known to enhance gas retention during proofing. These three hydrocolloids are largely used in gluten-free preparations, and many optimised concentrations alone and in combination (mixture designs) have been proposed. Nonetheless, the differences in bread quality that each of these gums produce are still not well understood. Thus, the objectives of this study were: (i) to unveil and compare the separate effects of XG, GG and HPMC on gluten-free batter and bread quality; and (ii) to explore the interrelationships between physicochemical and texture characteristics of gluten-free batter and bread. To meet these objectives, bread could not be formulated with a mixture of gums, but with each gum separately, and at different concentrations and water levels to create variability.

METHODOLOGY

Gluten-free bread was produced using a mixture of rice (50%), corn (30%) and quinoa flour (20%) to which sunflower oil (6% flour weight), white sugar (3%), refined salt (1.5%) and instant yeast (3%) were added following a standardised procedure. Twenty-seven formulations were produced with 1.5, 2.5, 3.5% XG and 90, 100, 110% of water (nine combinations); 2.5, 3.0, 3.5% GG and 90, 100, 110% of water (nine combinations); and 3.0, 4.0, 5.0% of HPMC and 80, 90, 100% of water (nine combinations). Batter was mixed for 6 min in a food processor equipped with a batter blade. Portions of 280 g were then poured to oiled and floured rectangular tins, and proofed at 30ºC and 85% RH for 60 min. Loaves were then baked in a convection oven at 190ºC for 60 min, and left to cool down before de-moulding. Determinations on batter were performed 30 min after the end of mixing, while analyses on baked loaves and bread crumb were carried out 24 h after baking. Using a texture analyser TA-XT plus (Stable Micro Systems, UK) fitted with specific fixtures, the batter rheology and bread crumb texture were characterised. From the stickiness analysis (**STK**) on batter, measures of stickiness (g), work of adhesion (g.s), and strength-cohesiveness (mm) were obtained; while from the back extrusion analysis (**BE**), firmness (g), consistency (g.s), cohesiveness (g) and viscosity index (g.s) of batter were measured. By means of a texture profile analysis (**TPA**) on bread crumb, hardness (g), adhesiveness (g.s), springiness (dimensionless), cohesiveness (dimensionless), gumminess (g), chewiness (g) and resilience (dimensionless) were measured. In addition, bread crumb water activity (Aw) and pH were quantified as well as loaf specific volume (ml/g) and baking loss (%). By image analysis of scanned slices of bread, the following crumb grain features were quantified: mean cell area (mm^2); cell density (number of cells/mm^2); cell size uniformity (nº cells <=5 mm^2 / nº cells > 5 mm^2); void fraction; mean cell aspect ratio; and mean cell solidity. The *FactoMineR* and *factoextra* packages in R were used to perform a principal component analysis (PCA) on the 24 variables.

RESULTS AND DISCUSSION

The first PC accounted for 45% of the variability and was mostly linked to quality properties measured after baking; namely, loaf volume, bread crumb TPA features and image analysis features. The first PC was highly correlated with loaf specific volume (r=-0.90), the image grain features of void fraction (r=-0.96), mean cell density (r=0.92), mean cell area (r=0.88), mean cell solidity (0.85), the crumb TPA features of chewiness (r=0.92), gumminess (r=0.92), hardness (r=0.88), and dough stickiness (r=-0.84), while moderately correlated with cell size uniformity (r=0.79), baking loss (r=-0.78), and TPA cohesiveness (r=0.69), adhesiveness (r=-0.68) and resilience (r=0.61) (Fig.1 , left). Since bread crumb grain (visual texture) can be linked with firmness (instrumental texture), the first PC was labelled as "bread crumb porosity". Proofing loaves that undergo a greater gas retention (i.e., higher volume) present higher moisture loss during baking, and tend to produce crumb of higher void fraction, higher mean cell area; therefore lower cell size uniformity (since there are more cells of large size in the crumb) and lower cell density (i.e., lower number of cells since the cells are larger). The first PC also elucidated that less sticky batters tend to have poor gas retention, producing bread crumbs of higher values of hardness, chewiness, cohesiveness and gumminess, and cells of higher solidity (i.e., more rounded, less elongated). The second PC accounted for 32% of the variation, and was highly correlated with the batter BE properties of viscosity (r=0.96), cohesiveness (r=0.92), consistency (r=-0.94) and firmness (r=-0.95), the batter STK properties of cohesiveness (r=0.88) and adhesion (r=0.80), and bread crumb pH (r=0.83) and Aw (r=0.78), while moderately correlated with the bread crumb TPA property of springiness (r=0.76) Since all of the above quality properties are related to viscosity, the second PC was labelled as "batter viscosity". Batters that are more viscous, as a result of greater free water content, will present higher measures of viscosity (BE), cohesiveness (BE and STK), but lower consistency (BE) and firmness (BE), and will tend to present higher dough adhesiveness (STK) and higher crumb Aw, pH and springiness (TPA) after baking. (Fig. 1, left).

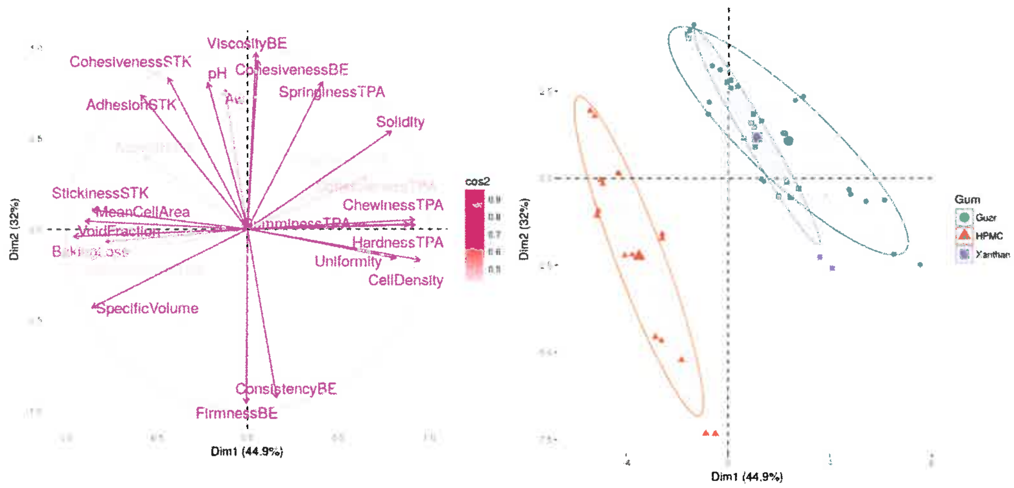

Figure 1. Two-factor map of gluten-free bread quality features (left) and projection by gum type (right)

Projections of the individual scores on the 2D-map of quality attributes (Fig. 1, right) revealed that XG and GG produced gluten-free batter and bread of comparable quality, although GG, particularly at high dose, can produce smaller loaves of harder and more resilient and cohesive crumb than XG. Comparing with XG and GG, the use of HPMC yielded batters of higher stickiness, consistency and firmness, which, when baked, produced loaves of higher volume, softer crumb, and larger and more elongated cells.