1. ABOUT THE DATASET

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Title: Data used in the article ‘Soluble fibres as sucrose replacers: effects on physical and sensory properties of sugar-reduced short-dough biscuits’

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Rights-holders: Thao H.T. Nguyen, University of Reading

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Description: This dataset contains data obtained from experimental work on the chemical, physical and sensorial characterisation of dough and biscuits when reducing 30% of sugar by replacing sucrose with four different soluble fibres (Nutriose® FM06, Promitor® 70R, Orafti® HIS, and Fibruline™ Instant). Data was obtained using a High Performance Liquid Chromatography (HPLC) method to analyse the degree of polymerisation of the fibres; a rheometer (viscoelastic properties of doughs); a standard balance, a moisture balance and water activity analyser (weight loss, moisture and water activity of biscuits); a caliper (dimensions of biscuits); texture analyser (resistance to penetration, number of peaks, breaking strength and fracturability); colorimeter (CIEL\*a\*b\* coordinates), and the trained sensory panel (biscuit profiling).

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Related publication:

Julia Rodriguez-Garcia, Rui Ding, Tara Nguyen, Simona Grasso, Afroditi Chatzifragkou and Lisa Methven (2022). Soluble fibres as sucrose replacers: effects on physical and sensory properties of sugar-reduced short-dough biscuits’. 2022. LWT-Food Science and Technology. In preparation.

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2. TERMS OF USE

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3. PROJECT AND FUNDING INFORMATION

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Title: ‘SureChoc: Sugar reduced chocolate and chocolate chip cookies to meet consumer sensory, naturalness and cost expectation’

Dates: January 2019- December 2019

Funding organisation: European Union

Grant no.: 19105

This EIT Food activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under Horizon2020, the EU Framework Programme for Research and Innovation. The research was carried out in collaboration with DouxMatok Limited, and Strauss Group.

4. CONTENTS

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Data processing and preparation activities

Data was collected in several Excel files. Different tabs have been assigned for different measurements. For data presentation an index tab at the beginning of each Excel file was created with the sample nomenclature, an explanation of the content of the file and a description of each of the variables studied. Data replicates are presented in columns with the heading ‘Replicate’ (e.g. Replicate 1, Replicate 2, Replicate 3).

File listing

1. ‘IngredientData’: this file contains data of the High Performance Liquid Chromatography analysis of the degree of polymerisation of each fibre.
	1. Table 1. Degree of polymerisation results from the experimental analysis carried out.
2. ‘DoughData’: this file contains data on the viscoelastic properties of doughs:
	1. Figure 1: Frequency dependence of the storage (G’) and loss (G”) modulus of the doughs.
	2. Figure 2: Frequency dependence of the tanδ of the biscuit doughs.
3. ‘BiscuitData’: this file contains the data of the analyses done in biscuits in terms of:
	1. Table 3: Weight loss, moisture, and water activity of the five biscuit samples.
	2. Table 4: Dimensions of the biscuits.
	3. Figure 3: Penetration representative curve profiles of biscuits
	4. Figure 4: Biscuit breaking strength and fracturability curve profiles obtained from the 3-point bending test.
	5. Table 5: Colour parameters of the five biscuit samples.
	6. Table 6: Mean sensory score for the five biscuit samples.
	7. Figure 4: PCA plot of the attributes that characterised the differences between the biscuits from the five formulations. Blue circles represent confidence ellipses of the sample position on the plot.

Variables explanation:

1. Control: Full sugar biscuit dough
2. Nutriose (N): 30% sugar reduced dough biscuit with Nutriose® FM06
3. Promitor (P): 30% sugar reduced dough biscuit with Promitor® 70R
4. Orafti (O): 30% sugar reduced dough biscuit with Orafti® HIS
5. Fibruline (F): 30% sugar reduced dough biscuit with Fibruline™ Instant
6. nRIU: Refractive Index Units is a dimensionless number
7. Frequency (rad/s or Hz): Rheological oscillation measurements
8. Elastic or Storage modulus (G'; Pa): Elastic component of a viscoelastic product
9. Viscous or Loss modulus (G'': Pa) Viscous component of a viscoelastic product
10. Loss tangent (tan delta): Tangent of the phase angle (δ) between stress and strain. tan δ = Gꞌꞌ/ Gꞌ.
11. Weight Loss (WL): Percentage of weight Loss during baking calcuated using the following formula: WL (%) = (Wdough-Wbiscuit / Wdough) ×100
12. Water activity (aw): Water content available for chemical reaction and microbiological growth
13. Moisture (%): Total amount of water in the sample
14. Length (cm): Maximum distance between end to end of the biscuit
15. Width (cm): Maximum distance between end to end of the cross section of the biscuit
16. Thickness (cm): Maximum distance through the biscuit parallel planes
17. Resistance to penetration (N·s): Total force to penetrate the biscuit
18. Number of peaks: the peaks are the evidence of local fractures of structures or layers when the probe penetrated them
19. Biscuit breaking strength (N): Maximum force to break the biscuit
20. Fracturability (mm): Distance at the point of break
21. Lightness (L\*): 0 (black) and 100 (white)
22. Colour coordinate a\*: -a\* (greenness) and +a\* (redness)
23. Colour coordinate b\*:-b\* (blueness) and +b\* (yellowness)
24. PCA: Principal Components Analysis

5. DATA WITHHELD

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Sensory profile raw data for biscuits are available on request from the corresponding author. The data are not publicly available due to the trained panel being employed by a third party, not the University of Reading.

6. METHODS

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Please see Materials and Methods section in the related article Rodriguez-Garcia et al. 2022 (in preparation), which includes Ingredients, Degree of polymerisation (DP) of soluble fibres, Dough and biscuit preparation, Biscuit dough rheological measurements, weight loss during baking, Water activity and moisture, biscuit dimensions, texture analysis, colour measurements, Sensory profiling, statistical analysis.

**Ingredients**

The ingredients used in the preparation of the short dough biscuits were soft wheat flour (protein 9.7 %, dietary fibre 3.5%, fat 0.98%, salt 0.03%), unsalted butter (82.9% fat), granulated sugar, salt, sodium bicarbonate, and skimmed milk powder (0.1% fat) (purchased from a local UK supermarket), ammonium hydrogen carbonate (APC Pure, UK). The following soluble fibres were used as sugar replacers: a resistant dextrin Nutriose® FM06 (Roquette, France); resistant maltodextrin Promitor® SGF 70R (Tate & Lyle, USA); a highly-soluble inulin powder Orafti® HSI (Beneo GmbH, Germany); and a soluble inulin Fibruline® Instant (Cosucra, Belgium), kindly donated by Caldic Ltd. (UK). Further specifications provided by the suppliers about the soluble fibres is presented in Table 1.

**Degree of polymerisation (DP) of soluble fibres**

The soluble fibres used as sugar replacers were analysed for their degree of polymerisation (DP) in an Agilent Infinity 1200 system (Agilent Technologies LDA, UK), equipped with a RI detector. Separation was carried out in an Aminex HPX-42A column (300 x 7.8 mm, 25 μm particle size) (Biorad, UK), heated at 80 °C. Isocratic analysis was performed using ultra-purified water as eluent at a flow of 0.5 mL/ min and an injection volume of 20 μL. OpenLab Chemstation software (Agilent Technologies LDA, UK) was used to interpret the chromatograms. The relative percentage of DP was calculated based on the ratio of each peak area to the total sum of integrated peak areas for each sample. Retention times for various DP were defined based on known concentrations of external standard maltooligosaccharide solutions (DP 2-8) (Megazyme Ltd, Ireland). Results are presented in Table 1.

**Dough and biscuit preparation**

Five dough (D) formulations were developed according to Laguna, Primo-Martín, et al. (2013b) in order to obtain the correspondent biscuits (B): a control formulation with no sugar replacement, and four formulations in which 30% of sugar was reduced by replacing sucrose with different soluble fibres (Table 2).Predictive values of Total solvent (TS), which is the sum of all sugars in grams and water in grams/100 g flour and Sugar concentration (%S), which is the grams of sugars divided by the sum of grams sugars plus grams water, were calculated for all the samples (M. Kweon et al., 2014);

The sugar and/or soluble fibres, the butter (at 20 °C), the leavening agents and the milk powder (predissolved in water) were mixed (Kenwood Chef XL, UK) with a K-beater at minimum speed for 30s. The dough was scraped from the sides of the bowl and then mixed for 3 min at speed 4. The dough was scraped down once more before adding the flour, and then mixed at minimum speed for 60 s. The dough rested for 10 min in a polyethylene bag (20 °C) before sheeting (Rondo, Chessington, UK) to 10 mm thickness. Dough pieces were cut (50 × 30 cm) and placed on parchment paper on a perforated tray (25 biscuits per tray), and baked in an electric deck oven (Polin Stratos, Verona, Italy) for 17 min at 175 °C (top heat at 70% and bottom heat at 30%). The biscuits were left to cool down at room temperature for 20 min and then they were packed in heat-sealed polyethylene bags and stored on cupboard boxes at 18 °C. The resulting products were named as follows: control sample (full sugar dough biscuit); Nutriose sample (30% sugar reduced dough biscuit with Nutriose® FM06); Promitor sample (30% sugar reduced dough biscuit with Promitor® 70R); Orafti sample (30% sugar reduced dough biscuit with Orafti® HSI); Fibruline sample (30% sugar reduced dough biscuit with Fibruline™ Instant). Three batches of each formulation were made on three different days.

**Biscuit dough rheological measurements**

Rheological properties of biscuit doughs were evaluated using an oscillatory rheometer (MCR 302, Anton Paar Ltd., UK) following the method described by (Tsatsaragkou et al., 2021) with some modifications. The viscoelastic properties of the doughs were measured using 50 mm diameter serrated parallel plates (profile 1 mm x 0.5 mm) with a 3 mm gap. After loading the sample, a rest time of 15 min was set to allow the sample to relax and reach the measurement temperature (25 °C). Strain sweep tests were performed to identify the linear viscoelastic region (LVE region) of the dough samples at a constant frequency (1 Hz. Oscillatory frequency sweeps between 0.1 – 100 Hz (0.63 – 628 rad/s) were performed at constant stress amplitude within the LVE region (0.0001 %). Dynamic rheological properties (mechanical spectra) of samples were recorded by monitoring the shear storage modulus G’, characterizing the elastic behaviour of the sample, and the shear loss modulus G”, describing the viscous behaviour of the sample. The loss factor, tan δ, was calculated according to the following equation:

tan δ = G”/G’

Oscillatory measurements were carried out in two dough pieces per batch of each dough formulation.

**Characteristics of the biscuits: Weight loss during baking**

Percent weight loss (WL%) of biscuits during baking was calculated using the following formula (Rodríguez-García et al., 2013):

WL (%) = (Wdough-Wbiscuit / Wdough) ×100

Where W denotes weight (g). Measurements were taken from 10 dough pieces and biscuits (before and after baking, respectively). This measurement was done in each of the three batches per formulation.

**Water activity and moisture**

A total and 4 g of crumbs were used to measure Moisture content was measured using a Sartorius M-Pact Series balance (Sartorius Lab Instruments, Germany) at 105 °C until constant weight. Water activity (aw) was measured using a HygroLab balance (Rotronic instruments, UK). For these measurements 10 biscuits of each batch were crumbed and each analysis was carried out in triplicate.

**Biscuit dimensions**

The biscuits length and width were recorded by placing 10 biscuits side-by-side; biscuits height was measured by stacking 10 biscuits (Rodríguez-García et al., 2013). These measurements were done once per formulation batch.

**Texture analyses**

The texture of the biscuits was measured using a TAXT-Plus Texture Analyzer (Stable Micro System, UK) with a 5 kg load cell. Biscuit texture was analysed following the methodology described by (Laguna, Vallons, et al., 2013) with some modifications:

A three-point bending probe and support (A/3PB) was sued to fracture the biscuits. The experimental conditions were test speed 1 mm/s; distance between supports, 20 mm; probe travel distance 6.5 mm; and trigger force 0.2 N. The parameters measured were the force at break (N), and the distance at break (mm) as the fracture strength and the fracturability, respectively.

A cylinder probe (2mm diameter) was used to penetrate the biscuits in the centre, at a test speed of 0.5 mm/s, to a distance of 60% of the total height of the sample. The parameters studied were the area under the curve as the resistance to penetration and the number of peaks as an index of crunchiness. All the analyses were performed on 10 biscuits of each batch.

**Colour measurements**

Colour measurements of the biscuit surface were carried out using a Chroma Meter CR-400 colorimeter (Kinolta Minolta, Warrington, UK). Three biscuits per batch were analysed. Results were expressed using the CIELAB system (illuminant C and 10° viewing angle). The parameters measured were L\* (L\* = 0 [black], L\* = 100 [white]), a\* ((–a\* = greenness and +a\* = red) and b\* ((–b\* = blueness and +b\* = yellow). The total colour difference (∆E\*) between the control sample and each of the muffins containing soluble cocoa fibre as a fat replacer was calculated as follows (Francis & Clydesdale, 1975):

∆E^\*=[(〖∆L〗^\* )^2+(〖∆a〗^\* )^2+(〖∆b〗^\* )^2 ]^(1/2)

The values used to determine whether the total colour difference was visually obvious were the following (Bodart et al., 2008):

∆E\* < 1 colour differences are not obvious for the human eye,

1 < ∆E\* < 3 minor colour differences could be appreciated by the human eye depending of the hue, and Chroma

∆E\* > 3 colour differences are obvious for the human eye.

**Sensory profiling**

A trained sensory panel (n = 8) with more than 2 years of experience, developed a consensus descriptive vocabulary of the sensory attributes including appearance, aroma, taste, mouthfeel and after-effects over 2 training sessions, using reference standards to assist in defining attributes where required (Supplementary Table S1). Whole biscuits were presented to panellists at each tasting on 3-digit coded ceramic plates. Scoring sessions were carried out twice, in these sessions samples were presented in a balanced monadic sequential and sample attributes were scored on visual analogue unstructured scales (0-100) with anchored extremes using Compusense cloud software (Compusense Inc., Canada). In order to minimize carryover effects, a 2 min interval was allowed between each sample. Panellists were asked to cleanse their palate between tastings with filtered warm water. All assessments were carried out in isolated sensory booths under artificial daylight and with the room temperature controlled at 23 °C.

**Statistical analysis**

One-way Analysis of Variance (ANOVA) was performed using XLSTAT software package (version 2019.3.1, Addinsoft, France). Multiple pairwise comparisons using Tukey’s HSD test were used to evaluate mean value’s differences (p<0.05).

Sensory data analysis was performed using Senpaq version 5.01 (QI Statistics, UK) using two-way ANOVA with sample fitted as a fixed effect, panellists as a random effect and both main effects tested against the sample by panellist interaction. Least significant differences were computed by Fisher’s post hoc test (p<0.05). Principle component analysis (PCA) was based upon the covariance matrix.