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## Data Article

## Data of texture profile analysis performed by different input settings on stored 'Nui' and 'Rahi' blueberries



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## ABSTRACT

Texture Profile Analysis is a well-established method for assessing mechanical properties of horticultural food products and consists of two compression cycles on a repeated motion to a given strain using a flat surface probe (i.e., compression plate). Input settings of target deformation (strain%) and duration (s) between compression cycles utilized for Texture Profile Analysis could influence output mechanical properties. The article provides data related to the ability of different Texture Profile Analysis operational settings to enable the separation of blueberries with variable mechanical properties. To create variable mechanical parameters of 'Nui' and 'Rahi' blueberries, fruit was stored in four relative humidity for 21 d at 4°C. For each storage humidity, mechanical properties of hardness (BH, N), hardness slope (BHS, kN m<sup>-1</sup>), apparent modulus of elasticity (E, MPa), and resilience (BR, -) were determined by utilizing two strain (15% or 30% of berry equatorial height). Meanwhile, mechanical parameters of cohesiveness (BCo, -), and springiness (BSp, -) were obtained by utilizing the combination of two strain (15% or 30%) and two duration between cycles (2 s and 10 s) as TPA operational settings. The statistical evaluation was conducted by one-way

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ANOVA, and the means of each storage humidity were separated according to the Tukey-HSD test ( $P = 0.05$ ). The data presented in this article was used to select the Texture Profile Analysis operational settings utilized in the article entitled "Influence of water loss on mechanical properties of stored blueberries" Rivera et al. [1].

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## Specifications Table

Subject	Agricultural sciences
Specific subject area	Postharvest quality
Type of data	Figures, statistical analysis.
How data were acquired	Texture Analyser (TA.XT plus, Stable Micro Systems, Surrey, UK) equipped with a 5 kg load cell and a 25 mm cylindrical flat-ended probe (P/25, Stable Micro Systems). Mechanical parameters of hardness, resilience, cohesiveness, hardness slope, and springiness were estimated from the double compression graph using Exponent software (Version 6.1.14.0, Stable Micro Systems), and the calculation procedures previously reported by Chiabrando et al. [2] for hardness, cohesiveness and resilience; Slaughter and Rohrbach [3] for hardness slope; and Hu et al. [4] for springiness. The apparent modulus of elasticity was calculated using the equation reported by Prussia et al. [5].
Data format	Analysed data (mean, standard error, ANOVA $P$ -value, and Tukey's multiple comparison test).
Parameters for data collection	Mechanical parameters of Texture Profile Analysis were assessed at 20°C on 'Nui' (highbush blueberry) and 'Rahi' (rabbiteye blueberry) stored for 21 d at 4.5°C in four storage humidity of 73%, 88%, 92% and 95% for 'Nui'; and of 74%, 81%, 89%, and 93% for 'Rahi'.
Description of data collection	Texture Profile Analysis was performed utilizing two strain (15% and 30%) to evaluate the mechanical parameters of hardness, hardness slope, resilience, and apparent modulus of elasticity. Texture Profile Analysis was performed utilizing the combination of two strain (15% and 30%) and two duration (2 s and 10 s) between compression cycles to evaluate mechanical properties of cohesiveness and springiness.
Data source location	Institution: Massey University City/Town/Region: Palmerston North, Manawatu Country: New Zealand Latitude and longitude (and GPS coordinates, if possible) for collected samples/data: 'Nui' and 'Rahi' blueberries were obtained from a commercial orchard located in Flaxmere (latitude: -39.62154, longitude: 176.784073), Hawke's Bay, New Zealand.
Data accessibility	Repository name: Mendeley Data DOI: 10.17632/sdntcmg8jr.1 Direct URL to data: <a href="https://data.mendeley.com/datasets/sdntcmg8jr/1">https://data.mendeley.com/datasets/sdntcmg8jr/1</a>
Related research article	S. Rivera, H. Kerckhoffs, S. Sofkova-Bobcheva, D. Hutchins, A. East, Influence of water loss on mechanical properties of stored blueberries, Postharvest Biol. Technol. 176 (2021) 111498. <a href="https://doi.org/10.1016/j.postharvbio.2021.111498">https://doi.org/10.1016/j.postharvbio.2021.111498</a> .

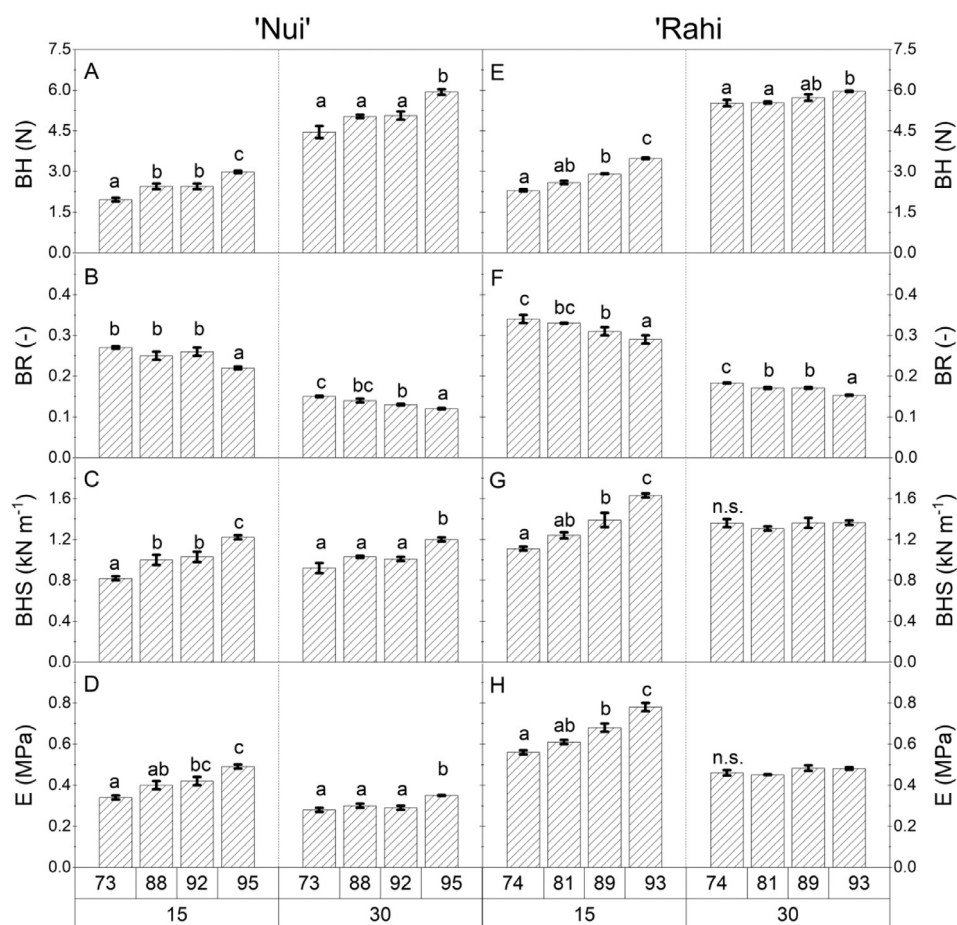
## Value of the Data

- Texture Profile Analysis performed using different operational settings can conduct variable ability to separate mechanical properties of blueberries stored on different humidity.
- These data are beneficial for the research community and the blueberry-related industry interested in assessing the postharvest quality of blueberries.

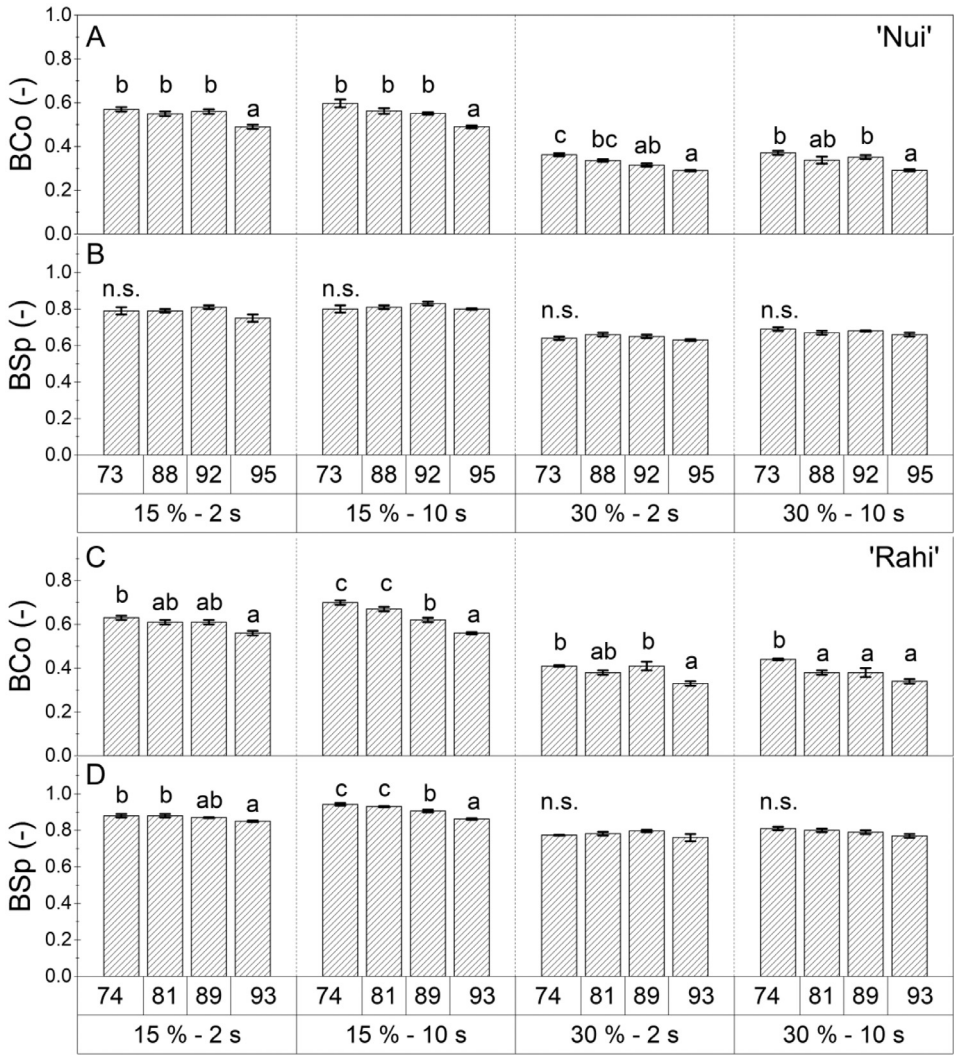
- These data might be used to optimise the operational settings for evaluating Texture Profile Analysis of stored blueberries.

## 1. Data Description

Data reported in this article describe the results obtained by evaluating the influence of four storage humidity on mechanical parameters of blueberry stored for 21 d at 4.5°C. After storage, the parameters of hardness (BH, N), hardness slope (BHS,  $\text{kN m}^{-1}$ ), resilience (BR, -), and apparent modulus of elasticity ( $E$ , MPa) were obtained by using two strains (15% or 30% of berry equatorial height) for operating texture analyser for two blueberries cultivars, 'Nui' and 'Rahi' (Fig. 1). The article also presents the data related to evaluating the influence of four storage



**Fig. 1.** Influence of storage humidity (73 %, 88 %, 92 %, and 95 % for 'Nui', and 74 %, 81 %, 88 % and 93 % for 'Rahi') for 21 d at 4.5°C on the average blueberry hardness (BH, A and E), resilience (BR, B and F), hardness slope (BHS, C and G) and the apparent modulus of elasticity ( $E$ , D and H) determined using strain of 15 % and 30 % of berry equatorial height in blueberries 'Nui' (A–D) and 'Rahi' (E–H). Columns (i.e., storage humidity) with the same letters for each target strain and cultivar were not statistically significant, according to Tukey's HSD test ( $P$ -value < 0.05). n.s. = ANOVA reports a  $P$ -value of > 0.05. Columns = mean of three replications of 26 berries each ( $n = 78$  berries). Bars = standard error of the mean of three replications.



**Fig. 2.** Influence of storage humidity (73 %, 88 %, 92 %, and 95 % for 'Nui', and 74 %, 81 %, 89 % and 93 % for 'Rahi') for 21 d at 4.5°C on the average cohesiveness (BCo, A and C) and springiness (BSp, B and D), determined using four operational settings of the combination of two strain (15 % or 30 % of berry equatorial height) and two duration between cycles (2 s or 10 s), in 'Nui' (A,B) and 'Rahi' (C,D) blueberries. Columns (i.e., storage humidity) with the same letters for each operational setting and cultivar were not statistically significant, according to Tukey's HSD test ( $P$ -value < 0.05). n.s. = ANOVA reports a  $P$ -value of > 0.05. Columns = mean of three replications of 13 berries each ( $n$  = 39 berries). Bars = standard error of the mean of three replications.

humidity for 21 d at 4.5°C on blueberry mechanical parameters of cohesiveness (BCo, -) and springiness (BSp, -). Cohesiveness and springiness were measured by using four operational settings obtained by the matrix combination of two strains (15% and 30%) and two durations between compression cycles (2 s and 10 s) for two blueberries cultivars, 'Nui' and 'Rahi' (Fig. 2).

## 2. Experimental Design, Materials and Methods

### 2.1. Blueberry material

Highbush 'Nui' (*Vaccinium corymbosum*) and rabbiteye 'Rahi' (*Vaccinium ashei*) blueberry were hand-harvested at 100% blue surface colour from a commercial orchard located at Flaxmere, Hawke's Bay, New Zealand on January 15th, 2018 for 'Nui' (Highbush blueberry) and February 2nd, 2018 for 'Rahi' (Rabbiteye blueberry). The fruit was immediately transported for 3 h in a polystyrene cooler box at  $19.1 \pm 1.0^\circ\text{C}$  and  $59.4 \pm 15.9\%$  humidity to the Postharvest Lab, Massey University (Palmerston North, New Zealand). Commercial maturity at harvest was determined by the ratio of total soluble solids (%) to acidity (% citric acid equivalent). The ratio of total soluble solids to acidity was  $9.4 \pm 1.0$  for 'Nui', and  $19.4 \pm 2.0$  for 'Rahi'.

### 2.2. Storage relative humidity treatments

Immediately after arriving at the Postharvest Lab, 72 healthy berries of 'Nui' and 'Rahi' blueberries were randomly distributed in twelve 0.578 L glass jars. In order to create different storage humidity treatments, glass jars were randomly assigned to airflow through the jar of either  $0 \text{ mL s}^{-1}$ ,  $0.25 \text{ mL s}^{-1}$ ,  $0.5 \text{ mL s}^{-1}$ , or  $1 \text{ mL s}^{-1}$  in triplicate, for 21 d of storage in a temperature-controlled room at  $4.5 \pm 0.1^\circ\text{C}$ . Airflow through each glass jar was generated following the methodology presented by Paniagua et al. [6]. Glass jars were closed with a lid containing two rubber septa. One rubber septa was used for dry air input (inlet) and another for air output (outlet). Airflows through the jars were regulated using needle valves, and the airflows were checked at the outlet every two days using a gas flow meter (ADM 1000, Agilent Technologies, CA, USA). For the airflow of  $0 \text{ mL s}^{-1}$ , two holes of 4 mm located on the cuvette lid were left open to allow air refresh by diffusion. Each airflow results in an humidity range, achieved as a result of the steady-state humidity inside the glass jar [6]. The resulting storage relative humidity was recorded by a logger (iButton<sup>®</sup>, Maxim Integrated, CA, USA). Storage humidity (average  $\pm$  standard deviation) of  $73.3 \pm 10.3\%$ ,  $88.2 \pm 1.2\%$ ,  $92.3 \pm 1.8\%$ , and  $95.0 \pm 0.25\%$  for 'Nui', and  $73.9 \pm 1.6\%$ ,  $81.2 \pm 0.5\%$ ,  $88.5 \pm 0.3\%$ , and  $93.3 \pm 0.42\%$  for 'Rahi' were created by the controlled supply of the airflow of  $1 \text{ mL s}^{-1}$ ,  $0.5 \text{ mL s}^{-1}$ ,  $0.25 \text{ mL s}^{-1}$ , and  $0 \text{ mL s}^{-1}$ , respectively.

### 2.3. Operational settings for Texture Profile Analysis

After 21 d of storage, healthy berries without any sign of mould growth or decay lesion were selected from each glass jar to assess Texture Profile Analysis (TPA) mechanical parameters.

A Texture Analyser (TA.XT plus, Stable Micro Systems, Surrey, UK) equipped with a 5 kg load cell and a 25 mm cylindrical flat-ended probe (P/25, Stable Micro Systems) was operated using different settings to evaluate Texture profile Analysis. Mechanical properties of hardness (N), hardness slope ( $\text{kN m}^{-1}$ ), apparent modulus of elasticity (MPa) and resilience (-) were assessed on 26 berries in triplicate ( $n=78$  berries) for each storage humidity, by utilising two strain targets (15% and 30% of berry equatorial height) as operational settings. Meanwhile, mechanical properties of cohesiveness (-) and springiness (-), were assessed on 13 berries in triplicate ( $n=39$  berries) for each storage humidity by utilizing four operational settings obtained by the combination of two strain (15% and 30%), and two duration (2 s and 10 s) between compression cycles.

The operation process for the Texture Profile Analysis was performed considering a starting position of the probe of 21 mm height from the platform surface. The probe started moving at a pre-test speed of  $1.6 \text{ mm s}^{-1}$  until touching the berry as achieved by recognising the trigger force of 0.06 N. At that point; the probe starts the first compression (downstroke) at a test speed

of 0.8 mm s<sup>-1</sup> until the target strain of 15% or 30% of the berry equatorial height is achieved. After the selected deformation distance is achieved, the probe ascends (upstroke) at the test speed of 0.8 mm s<sup>-1</sup> to the position where the probe recognised the trigger force for the first compression. The first compression cycle is completed, and the probe waits for the selected duration between cycles of 2 s or 10 s. After the selected waiting time is complete, the probe starts the second compression, descending at the same test speed to the same target distance as the first compression. Finally, the probe ascends at post-test speed of 0.8 mm s<sup>-1</sup> to the starting position. All acquisitions were made with a resolution of 250 points per second.

During the Texture Profile Analysis, the blueberries were placed with the stem-calyx axis oriented parallel to the surface over a flat metal ring of 10 mm internal diameter and 1 mm height. Although the compression should be performed by paralleled flat surfaces using flat surface samples [7], for small fruit such as blueberries, the preparation of cylindrical samples of similar size by using cork borer and blade is not possible. Therefore, Texture Profile Analysis evaluations of whole fruit are preferred. Hence, the flat metal ring of 10 mm allows steady support of the berry to the Texture Analyser platform surface, avoiding any balancing movements during and between compression cycles.

Mechanical properties of berry hardness, hardness slope, resilience, cohesiveness, and springiness were estimated from the obtained compression graphs using Exponent software (Version 6.1.14.0, Stable Micro Systems). Hardness, hardness slope, and resilience were obtained using the first compression cycle immediately before the waiting time has started, and cohesiveness and springiness, using both compression cycles. Hardness was calculated as the maximum force (N) to achieve 15% or 30% strain [2]. Hardness slope or chord stiffness as the slope of a straight line drawn between the trigger force of 0.06 N and the maximum force at 15% or 30% strain [3]. Resilience was calculated as the ratio of the area of work (force X displacement) during withdrawal (upstroke) of first compression to the area of work during downstroke of first compression [2]. Cohesiveness was calculated as the ratio of the area of work during the second compression cycle to the area of work during the first compression cycle [2]. Springiness was calculated as the ratio of displacement (mm) during downstroke compression of the second cycle to the displacement (mm) during downstroke compression of the first cycle [4].

The apparent modulus of elasticity (MPa) was calculated following the equation for parallel plate contact of spherical samples of viscoelastic behaviour (Eq. (1)) [5].

$$E = \frac{0.338 F (1 - \mu^2)}{D^{3/2}} \times \left[ K_U \times \left( \frac{1}{R_U} + \frac{1}{R'_U} \right)^{1/3} + K_L \times \left( \frac{1}{R_L} + \frac{1}{R'_L} \right)^{1/3} \right]^{3/2} \quad (1)$$

Where,  $E$  is the apparent modulus of elasticity (Pa);  $F$  is the force (N) at selected deformation distance (15% or 30% strain);  $D$  is the probe displacement (m) at selected deformation distance;  $\mu$  is the blueberry Poisson's ratio (dimensionless);  $R_U$  and  $R'_U$  are the minimum and maximum, respectively, radii of curvature (m) of convex shape object at the upper point of contact (plate probe);  $R_L$  and  $R'_L$  are the minimum and maximum, respectively, radii of curvature (m) of convex shape object at the lower point of contact (platform support).  $K_U$  and  $K_L$  are constants calculated from the geometry of the upper and lower point of contact, respectively. A Poisson's ratio ( $\mu$ ) of 0.4 was assumed for blueberries [5]. Assumptions for spherical objects were considered, thus  $R_U$ ,  $R'_U$ ,  $R_L$ ,  $R'_L$  were equals to the radii of curvature ( $R$ ) and  $K_U=K_L=1.351$  [4]. Radii of curvature were calculated for each berry by the equatorial diameter obtained from Texture Analysis readings.

#### 2.4. Statistical analysis

Twenty-six readings (26 berries) of each Texture Profile Analysis response variables of hardness (N), hardness slope (kN m<sup>-1</sup>), resilience (-), and apparent modulus of elasticity (MPa) obtained by the same compression displacement were averaged for each storage humidity treatment, in triplicate. Consequently 78 berries were utilised for each storage humidity treatment

to evaluate hardness, hardness slope, resilience and apparent modulus of elasticity. For each blueberry cultivar ('Nui' and 'Rahi'), the effect of the storage humidity treatments on hardness, hardness slope, resilience, and apparent modulus of elasticity for each of the two strain (15% or 30%), was estimated by one-way ANOVA and the means between humidity treatments were separated according to Tukey-HSD test ( $P$ -value < 0.05). Assumptions of normality and equal variance were examined before ANOVA was performed.

Thirteen readings (13 berries) of each Texture Profile Analysis response variables of cohesiveness (-) and springiness (-) obtained by the same operational setting were averaged for each storage humidity, in triplicate. Consequently 39 berries were utilised for each storage humidity treatment to evaluate cohesiveness and springiness. For each blueberry cultivar ('Nui' and 'Rahi'), the effect of storage humidity treatments on cohesiveness and springiness for each of the four operational settings (matrix of two target strain% and two duration between cycle) was estimated by one-way ANOVA and the means were separated according to Tukey-HSD test ( $P$ -value < 0.05). Assumptions of normality and equal variance were examined before ANOVA was performed.

Statistical analysis was performed using statistical software InfoStat 2019 (Universidad Nacional de Córdoba, Argentina), and figures were plotted using Origin 2019b (OriginLab Corporation, MA, USA).

## Ethics Statement

Ethics statements are not required for the presented data. Procedures utilised to generate the data does not provide unusual hazards. In addition, this work did not consider the use of human or animal subjects.

## CRedit Author Statement

**Sebastian Rivera:** Conceptualization, Methodology, Formal analysis, Investigation, Visualization, Writing – original draft; **Huub Kerckhoffs:** Conceptualization, Supervision, Writing – review & editing; **Svetla Sofkova-Bobcheva:** Supervision, Writing – review & editing; **Dan Hutchins:** Resources, Supervision, Writing – review & editing; **Andrew East:** Conceptualization, Methodology, Resources, Supervision, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

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## Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.dib.2021.107313](https://doi.org/10.1016/j.dib.2021.107313).

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