

Final Report

March 10, 2026

Client: 10257596 Manitoba Inc.

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Project Title: Validation of In-Silico Sensory Prediction Models against In-Vitro Electronic Tongue Analysis for Polyphenolic Bitterness Masking. - BCS

Contract Services Agreement Date: January 29, 2026

Completed by: Richardson Centre for Food Technology and Research

I. Background

The client contracted RCFTR to test various compounds for bitterness testing using the RCFTR Alpha Mos Astree Electronic Tongue. Client will then assess the correlation between electronic tongue bitterness scoring results and the client's proprietary Codex Resonance Framework algorithm.

II. Methodology

RCFTR prepared the necessary standards for calibrating the electronic tongue as summarized in Table 1.

Table 1. Standards for Electronic Tongue Calibration.

Standard Name	Concentration
Hydrochloric Acid	0.01 M
Sodium Chloride	5.844 µg/mL
Monosodium glutamate	18.71 µg/mL
Caffeine	0.05 mg/mL
Acetaminophen	0.02 mg/mL
Famotidine 1	0.02 mg/mL
Famotidine 2	0.05 mg/mL
Quinine 1	0.01 mg/mL
Loperamide	0.005 mg/mL
Quinine 2	0.04 mg/mL
Denatonium Benzoate	0.5 mg/mL

The seven (7) sensors on the electronic tongue were hydrated, calibrated to ensure reproducible signal capture, and went through diagnostic testing to ensure sample discrimination and stability ensuring the instrument was ready for sample testing.

RCFTR then prepared four (4) different compounds at three (3) different concentrations (1, 5- and 25-fold dilution) totalling 12 solutions (Table 2).

Table 2. Compounds for Bitterness Testing.

Sample Name	Sigma Alrich Catalogue No.	Dilution No.	Dilution Factor	Concentration
Naringin	71162-25G	1	1	0.2 mg/mL
Naringin	71162-25G	2	5	0.04 mg/mL
Naringin	71162-25G	3	25	0.008 mg/mL
Quercetin	Q4951-10G	1	1	0.5 mg/mL
Quercetin	Q4951-10G	2	5	0.1 mg/mL
Quercetin	Q4951-10G	3	25	0.02 mg/mL
Curcumin	C1386-5G	1	1	1 µg/mL
Curcumin	C1386-5G	2	5	0.2 µg/mL
Curcumin	C1386-5G	3	25	0.04 µg/mL
Chlorogenic Acid	C3878-250MG	1	1	0.5 mg/mL
Chlorogenic Acid	C3878-250MG	2	5	0.1 mg/mL
Chlorogenic Acid	C3878-250MG	3	25	0.02 mg/mL

III. Results

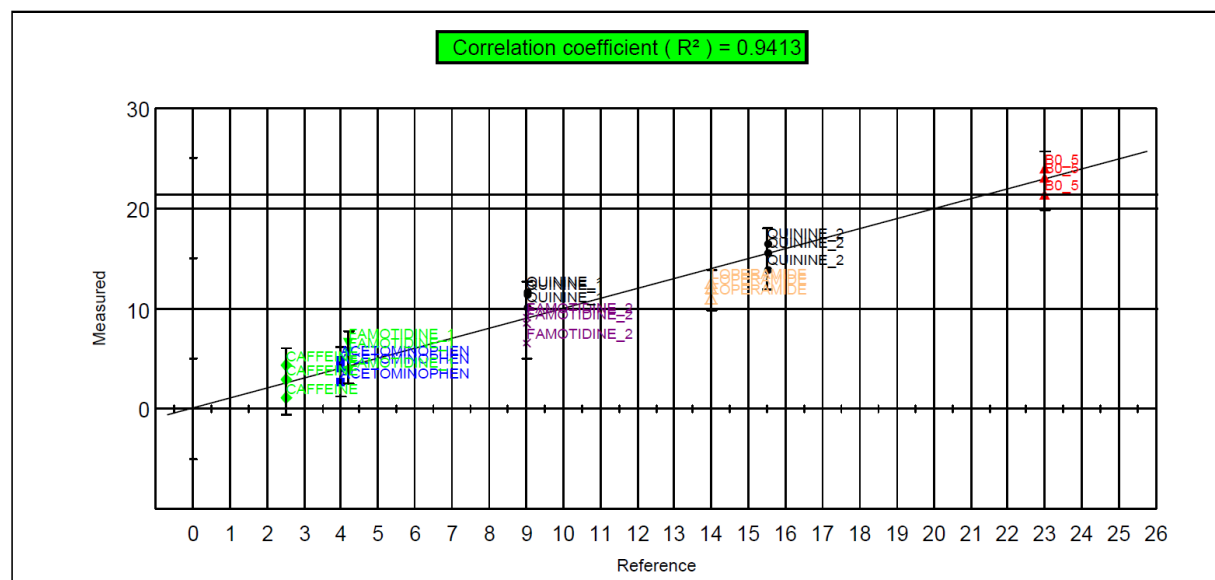
The eight (8) bitter standards were tested in triplicate and their respective mean $\pm$ standard deviation (SD) values are summarized in Table 3, in addition to the “in vivo” reference scores.

Table 3. Bitterness Standards Data.

Sample Name	Concentration (mg/mL)	Reference	Mean Bitterness Value (n=3)	SD
Caffeine	0.05	2.5	2.81	1.34
Acetaminophen	0.02	4	3.87	0.93
Famotidine 1	0.02	4.2	5.28	1.19
Famotidine 2	0.05	9	8.04	1.12
Quinine 1	0.01	9	11.15	0.69
Loperamide	0.005	14	11.82	0.66
Quinine 2	0.04	15.5	15.39	1.06
Denatonium Benzoate	0.5	23	22.86	1.06

A standard curve of measure mean bitterness values (n=3) versus reference score was plotted with a correlation coefficient (R^2) of 0.9413.

Figure 1. Bitterness Standard Curve.



The four (4) compounds were tested in triplicate at three different concentration levels and their respective mean $\pm$ SD values are summarized in Table 4.

Table 4. Measured Bitterness Data for Four (4) Compounds at Three Different Concentration Levels.

Sample Name	Sigma Alrich Catalogue No.	Dilution No.	Concentration	Mean Bitterness Value (n=3)	SD
Naringin	71162-25G	1	0.2 mg/mL	2.01	1.00
Naringin	71162-25G	2	0.04 mg/mL	3.10	1.56
Naringin	71162-25G	3	0.008 mg/mL	3.98	1.36
Quercetin	Q4951-10G	1	0.5 mg/mL	4.09	0.817
Quercetin	Q4951-10G	2	0.1 mg/mL	5.46	1.18
Quercetin	Q4951-10G	3	0.02 mg/mL	3.29	1.77
Curcumin	C1386-5G	1	1 μ g/mL	7.12	1.53
Curcumin	C1386-5G	2	0.2 μ g/mL	6.56	1.58
Curcumin	C1386-5G	3	0.04 μ g/mL	5.48	0.857
Chlorogenic Acid	C3878-250MG	1	0.5 mg/mL	20.19	1.32
Chlorogenic Acid	C3878-250MG	2	0.1 mg/mL	16.58	1.50
Chlorogenic Acid	C3878-250MG	3	0.02 mg/mL	5.44	0.96

A principal component analysis plot for each of the three dilutions are shown in Figures 2, 3 and 4.

Figure 2. Principal Component Analysis for Four (4) Compound at Dilution No. 1.

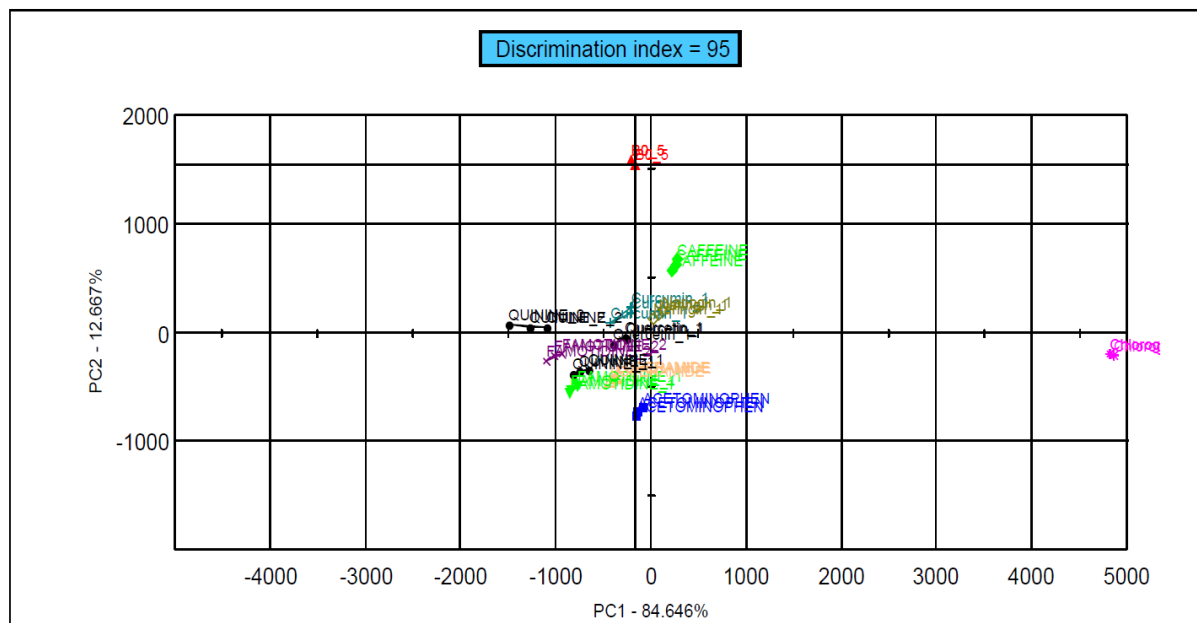


Figure 3. Principal Component Analysis for Four (4) Compound at Dilution No. 2.

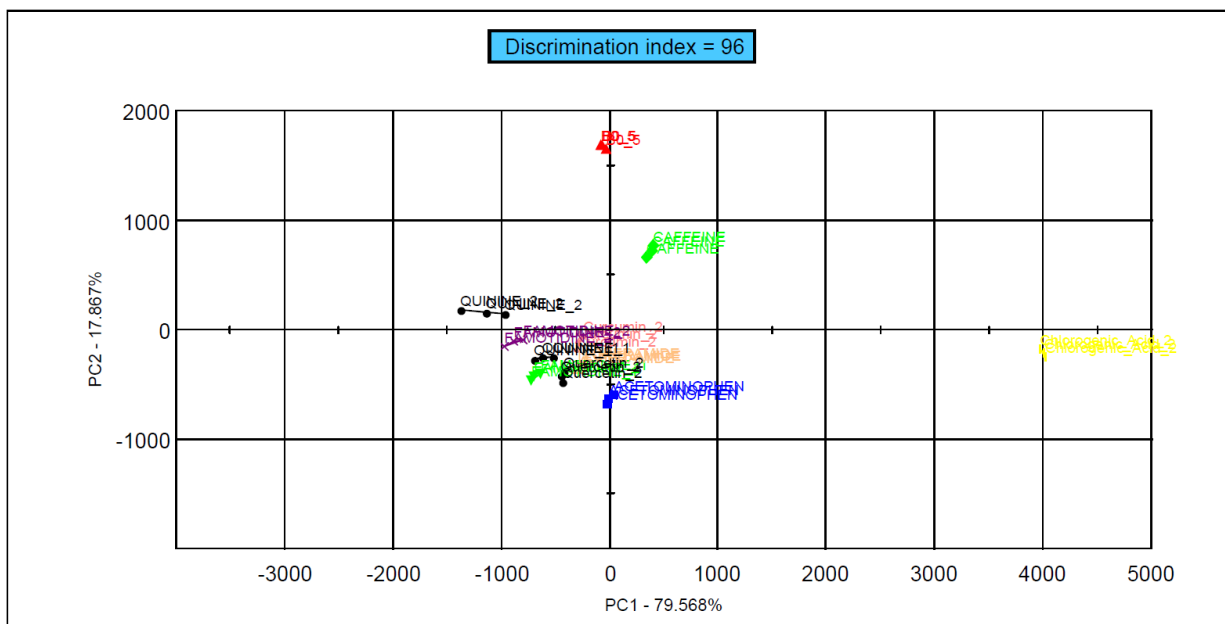
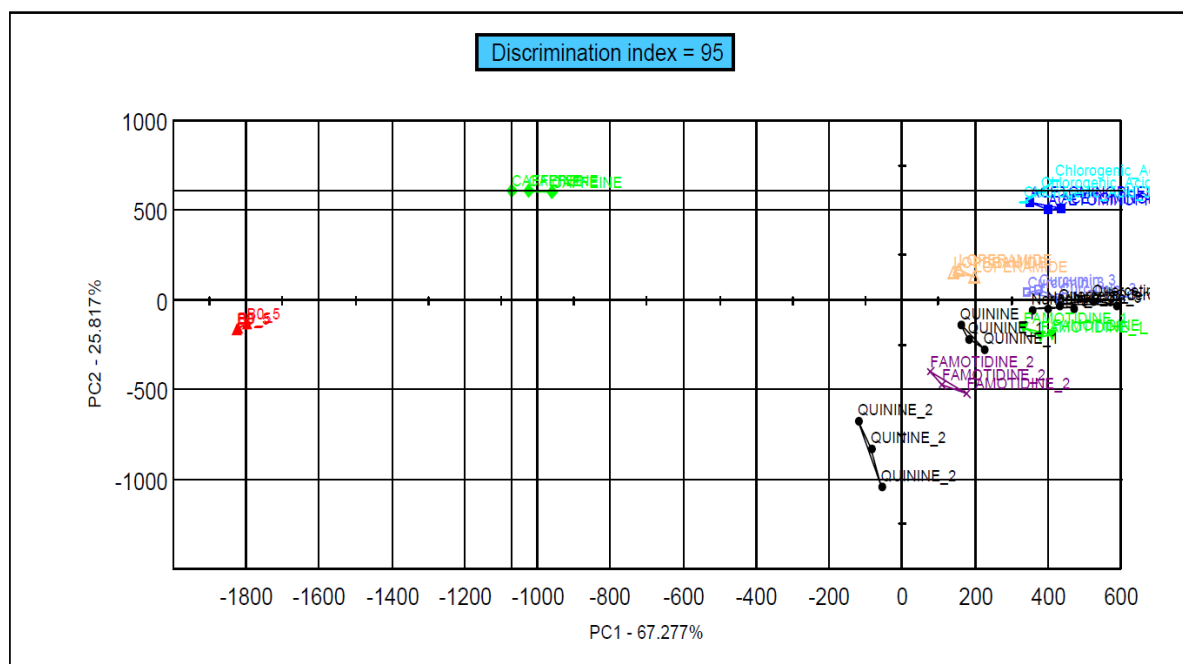


Figure 4. Principal Component Analysis for Four (4) Compound at Dilution No. 3.



IV. Discussion and Conclusion

RCFTR tested compounds naringin, quercetin, curcumin and chlorogenic acid for their bitterness score using the RCFTR Alpha Mos Astree Electronic Tongue. Each compound was tested at three different concentration levels (1-, 5- and 25-fold dilution) and their respective bitterness scores are summarized in Table 4.

A clear trend in bitterness scoring was observed for chlorogenic acid across the three dilutions: The most concentrated solution had the highest bitterness score (20.19 ± 1.32) followed by lower bitterness scores with the 5- and 25-fold diluted solutions, e.g. 16.58 ± 1.50 and 5.44 ± 0.96 , respectively. Chlorogenic acid is moderately to good water soluble and RCFTR experienced no issues with the dissolution of chlorogenic acid.

Trends in bitterness scoring were somewhat inconsistent for compounds naringin, quercetin and curcumin. For example, the bitterness score of naringin was higher at a 25-fold diluted concentration level (3.98 ± 1.36) as compared to the corresponding stock solution (2.01 ± 1.00). This result may be explained by the poor water solubility of naringin. The Astree Electronic Tongue measures only what is dissolved in solution and for compounds with low water solubility, the electronic tongue may only be measuring partially dissolved fractions leading to both inconsistent results and a narrow response range.

The PCA plots in Figures 2, 3 and 4 demonstrate good discrimination among the bitterness scores across standards and compounds.

Thank you for choosing to conduct work at the RCFTR. If you have any questions, please contact us by phone or email.