Determining Product Concentration

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ABSTRACT

Sensus creates essences and concentrates of various agricultural products with tea and coffee currently being the best selling products. Tea and coffee concentrates need to be described by their concentration level. Currently, reflective refractometers are used to determine a refractive index which is converted to the °Brix values. An evaluation of benchtop refractometers was conducted to determine which one (if any) would improve the quality of concentration data.

INTRODUCTION

When dealing with sugar solutions, °B (degrees Brix) is used to describe the amount of dissolved sucrose. This is common in fruit juices, wines, and some other products. °Brix is generally determined by measuring a physical property and relating that to the percentage of sucrose in a solution. This physical property can be various properties such as density, specific gravity, refractive index, or infra-red vibrational wavelengths. This means that any solution can be analyzed to determine a °Brix measurement, even if little to no sucrose is in solution. While this might at first seem to be a totally erroneous method, it isn't necessarily so. Consider that as the concentration of a solute (or in the case of tea and coffee, solutes) increase, the refractive index will change. This will provide an apparent °Brix reading. This °Brix reading can either be used directly or related to actual concentration of solutes (which can be determined by drying or percent moisture analyses). However, using refractive index to determined °Brix is predicated upon one important factor, that all solutes are actually in solution (and thus affecting refractive index) and not suspended (and thus not affecting refractive index). Additionally, there is the danger of suspended solids settling on the instruments prism and interfering with the measurement. Density and specific gravity might solve the problems of suspended solids settling on the prism and possibly of suspended solids be correctly accounted for. There is the very real possibility that the density would be different if the solutes are suspended versus in solution. However, for many compounds the affects are very small and likely within experimental error. Compounds that dramatically affect density do so generally by affecting the volume of the solution. While this does occur it is usually the exception and not the rule. Infra-red is specific for sugar vibration bands and therefore wouldn't work for other solutes.

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MATERIALS AND METHODS

Three refractometers were tested: AR700 (Reichert, Depew, NY), RX-5000a (Atago USA, Bellevew, WA), and J357 (Rudolf Research Analtyical, Hackettstown, NJ). Four tea concentrates, one tea powder, and two coffee concentrates were all tested at various concentration levels on all three instruments. Samples were measured in triplicate and the standard deviation of the results were compared.

RESULTS AND DISCUSSION

Testing the refractometers with sucrose solutions showed that all three instruments were in agreement (accurate) and very consistent (precise). It was clear from sucrose solutions that were sucrose solutions the main samples to be tested that any of the three systems would be acceptable and the "best" instrument would be based on secondary considerations such as price, sample throughput, user interface, etc. With tea and coffee concentrates, the instruments performed very differently. Table 1 is the standard deviations observed for each sample. One can see that the average standard deviation across all the samples was lowest in instrument #2 (0.12°B), next was instrument #3 (0.21°B), followed by instrument #1 (0.29°B). In addition to having the highest average standard deviation, instrument #1 reported "Bad Sample" on many of the tests. There seemed to be specific concentrations where the instruments performed poorly. For instance, if you remove Tea #1 @ 7.66 and 22.88°B, along with Tea #3 @ 5.87 and 15.93°B, then the average standard deviation for instrument #3 is only 0.05°B.

Another issue to consider is temperature of analysis. The same sample of tea #1 was measured at 20°C and 40°C. The results are presented in Table 2. On can see a significant change in apparent °B reading of almost 4.5°B on average.

Based on these results, if a refractometer is to be purchased, instrument #2 seems to be the top performer, followed by instrument #3. Instrument #1 is not recommended due to longer analysis time, numerous "Bad Sample" readings, and having the highest variability.

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Table 1. Standard deviations of the three refractometers on various tea and coffee samples.

		Standard Deviation		
Sample	Nominal °Brix	Instrument #1	Instrument #2	Instrument #3
Tea #1	53.48	0.04	0.06	0.06
Powder #1	12.43	0.23	0.14	0.32
Powder #1	19.77	1.02	0.18	1.15
Tea #2	51.08	0.03	0.00	0.01
Tea #2	26.00	0.08	0.02	0.06
Tea #2	10.43	0.04	0.00	0.02
Tea #2	0.54	0.01	0.00	0.01
Tea #1	48.28	0.22	0.07	0.05
Tea #1	22.88	0.14	0.35	0.08
Tea #1	7.66	1.46	0.63	0.65
Tea #1	0.54	0.02	0.00	0.01
Tea #3	37.25	0.10	0.09	0.16
Tea #3	15.93	--	0.31	0.42
Tea #3	5.87	1.35	0.46	0.46
Tea #3	0.23	0.17	0.05	0.06
Tea #4	10.73	--	0.07	0.31
Coffee #1	57.03	0.01	0.00	0.13
Coffee #1	26.45	0.62	0.08	0.14
Coffee #1	9.95	0.59	0.13	0.55
Coffee #1	0.66	0.21	0.08	0.20
Coffee #2	51.36	0.00	0.00	0.01
Coffee #2	28.87	0.09	0.00	0.07
Coffee #2	5.72	0.01	0.11	0.04
Coffee #2	0.54	0.01	0.00	0.01
Average		0.29	0.12	0.21

Table 2. Affect of measurement temperature on apparent °Brix

		Average response		
Tea #1 Temp (°C)	Nominal °Brix	Instrument #1	Instrument #2	Instrument #3
20	50	49.45	49.11	48.47
40		53.33	53.78	53.35

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