condi food
HYPERSPECTRAL INSPECTION SYSTEMS

Condi Food BV

Capability for in-line analysis of tomato acidity

Ali Ghamati
November 4th, 2020

Contact
Condi food BV
Oosteinde 36, 2361 HE Warmond, Nederland
+31 71528 4962, www.condifood.com

Introduction

Conventional quality control of tomatoes is based on quantitative measurements of sugars, acids, colour and firmness. Typically, one or more of these parameters are measured in order to predict the maturity or taste of tomatoes. However, conventional measurements of these parameters as shown in Figure 1 are mostly both destructive and time consuming. Therefore they are not applicable as a real time and in-line solution.

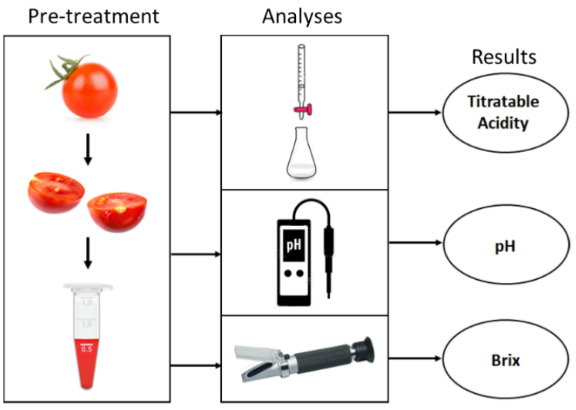

Figure 1: Slow and destructive conventional analysis methods for the quality control of tomatoes. Each quality parameter requires a different analysis.

Condi Food developments

Rapid and non-destructive in-line solutions for the analyses of Brix (sugar content) and the ripeness of tomatoes have been shown before and implemented by Condi Food using hyperspectral imaging. In addition to these analyses, Condi Food now has the capability to predict the acidity of tomatoes (Titratable Acidity and pH) using hyperspectral imaging (HSI) as shown in Figure 2.

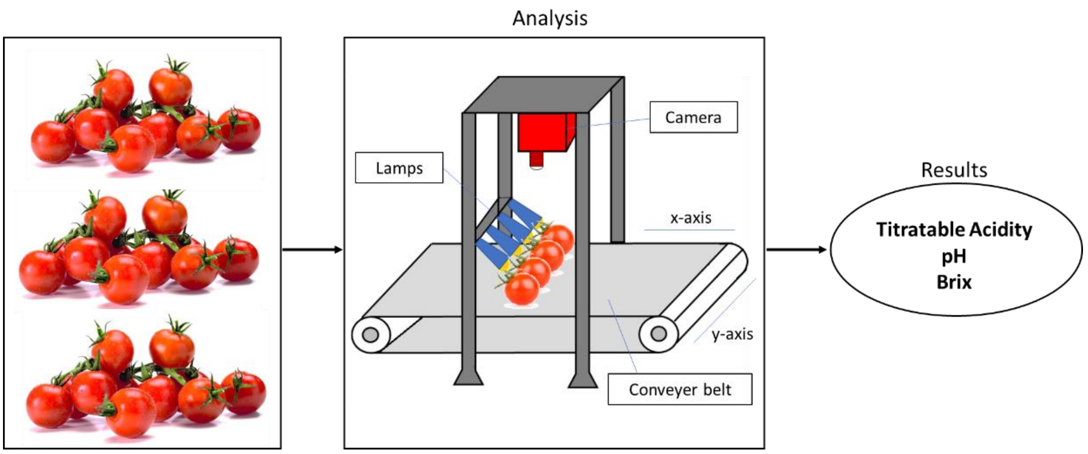

Figure 2: Rapid and non-destructive hyperspectral analysis. Three quality parameters are measured in one scan.

Hyperspectral analysis of tomato acidity

Developing a spectroscopic method for acidity analysis of tomatoes is challenging. For example, the acidity content of the ripe cherry tomatoes used in the method development is about 20 times lower than the sugar content. The spectroscopic signals of the acid compounds in tomatoes are therefore observed at much lower intensities. Moreover, these signals overlap with the signals of other compounds in tomatoes. Furthermore, the small cherry tomatoes (diameter ~20 mm) yield a low amount of sample material for chemical analyses. The next challenge was the requirement to develop a method capable of measuring 4 lanes simultaneously. Therefore, the projected image of a single tomato on the camera sensor accounts for only 4% of the available spatial pixels (y-axis). Thus, the spatial resolution is greatly compromised. Despite these challenges, Condi Food was able to develop a hyperspectral method to predict the titratable acidity (TA) of tomatoes. Moreover, the method proved to be more accurate compared to existing studies performed with vibrational spectroscopy and a Brix-Acidity meter which is a widely applied destructive reference technique in the food industry. An overview of tomato quality parameters and their corresponding accuracies as obtained by Condi Food and existing studies is listed in Table 1.

Table 1: Comparison of method accuracies of Condi Food with other studies which apply vibrational spectroscopy to predict quality parameters of tomatoes.

Parameter	Author	Absolute accuracy [a]	Relative accuracy [a]
pH	Condi Food	0.06	14%
	Huang et. al. [1]	0.24	22%
Brix	Condi Food	0.55	17%
	Huang et. al. [1]	0.74	21%
	Flores et. al. [2]	1.10	17%
	Torres et. al. [3]	1.18	18%
TA	Condi Food	0.10	8%
	Flores et. al. [2]	0.14	25%
	Torres et. al. [3]	0.12	24%

[a] Best results shown for accuracies based on 95% confidence interval.

Impact

Studies have shown that sugars and acids, and in particular the ratio between the two are important for the overall taste of tomatoes[4-6]. Therefore, the capability for inline analysis of tomato acidity in addition to sugar analysis can improve tomato sorting applications. This creates new business opportunities in marketing, pricing and positioning in relation to competition.

References

[1] Huang, Y., Lu, R., Chen, K. Assessment of tomato soluble solids content and pH by spatially-resolved and conventional Vis/NIR spectroscopy. *Journal of Food Engineering*, 2018, Vol. 236, PP.19-28.

[2] Flores, K., Sanches, M. T., Perez-Marin, D., Guerrero, J. T. et. al. Feasibility in NIRS instruments for predicting internal quality in intact tomato. *Journal of Food Engineering*, 2009, Vol. 91, PP. 311-318.

[3] Torres, I., Perez-Marin, D., De la Haba, M. J. Fast and accurate quality assessment of Raf tomatoes using NIRS technology. *Postharvest Biology and Technology*, 2015, Vol. 107, PP. 9-15.

[4] Grierson, D., and Kader, A.A. Fruit ripening and quality. *Springer book, The Tomato Crop*, 1986, PP. 241-280.

[5] Baldwin, E.A., Scott, J.W., Einstein, M.A., et al. Relationship between Sensory and Instrumental Analysis for Tomato Flavor. *Journal of the American Society for Horticultural Science*, 1998, Vol. 123, No. 123, PP 906-915.

[6] Harvest to Table – Tomato flavour explained, Retrieved from: https://harvesttotable.com/tomato-flavor-explained/ on 26 March 2020.