AUTHENTICATION OF *TOKAJ ASZÚ* WINE (HUNGARICUM) WITH NEAR INFRARED SPECTROSCOPY AND AQUAPHOTOMICS

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Summary: Production of *Tokaj Aszú* wines with grape must concentrate is considered as an adulteration by the wine experts. Tracking this type of adulteration is however often difficult due to the use of reference methods which, presents diverse challenges. This study reports on the potentials of NIRs to detect this type of adulteration using the aquaphotomics approach.

Introduction: Tokaj wines are delicacies with a special place in Hungarian national wine mythology and Hungarian wine history. The excellence of these wines has been mainly attributed to favorable climatic conditions in some Hungarian wine growing regions that make the berries tolerant to the mould, Botrytis cinerea and impart unique tastes and flavor in the berries. Carrying the nation's reputation on its shoulders, it is prudent that the wines remain in their desired states of quality, without tampering but this is often challenging using the traditional reference methods only as they are slow and often expensive. Aquaphotomics is a novel scientific discipline involved with the study of water and aqueous systems, using light-water interactions. Thus, the aim of the study was to apply this new approach for the determination of adulteration in Tokaj wine using grape must concentrate (G.M.C) as an adulterant.

Method: Two types of non-adulterated *Tokaj Aszú* wine (Ford_I_2 and Ford_II_2) with a two days maceration period of reused Botrytized berries and known sugar concentrations of 98.9 g/L and 130.2 g/L were artificially adulterated with G.M.C of 775.3 g/L sugar concentration. The adulteration was done in four increasing levels (C1-C4) with the aim of mimicking the sugar concentration of the non-adulterated tokaj wines (Table 1). Each of the samples were prepared in triplicates and randomly scanned with two near infrared spectroscopy devices: a bench top (Metri NIR, 740-1700nm) and a handheld (NIRscan Nano, 900-1700nm) spectrometer. Three consecutive scans were recorded for each sample and purified water (MQ) was also scanned after every five samples. Multivariate analysis of the data was done in R-project using the aquap2 package.

Table 1: List of adulterated samples and their targeted sugar concentration

ARTIFICIAL ADULTERATION	SUGAR CONTENT, G/L
Ford_II_2_C1	130.2
Ford_II_2_C2	168.2
Ford_II_2_C3	238.8
Ford_II_2_C4	254.5
Ford_I_2_C1	168.2
Ford_I_2_C2	203.5
Ford_I_2_C3	239.6
Ford_I_2_C4	254.5

Results and discussion: PCA analysis of the data from both instruments showed distinct separation between the adulterated wine samples and their non-adulterated counter-part for both Ford_I_2 and Ford_II_2 (Figure 1, a). There was also clear separation for C1-C4 adulteration of the wines. An R^2CV of 0.9632 (RMSECV: 11.33 g/L) was achieved for PLSR analysis with the bench top instrument and R^2CV of 0.8701 (RMSECV: 20.2 g/L) with the handheld one (Figure 2, b) for Ford_II_2 adulterated wines. A decreasing pattern in absorption was observed at the wavelengths representing less hydrogen bonded water with increasing adulteration with both sample types as shown in the aquagram plots of both instruments for Ford_II_2 (Figure 1, b and Figure 2, a). The study showed the capability of the aquaphotomics technique to determine adulteration of *Tokaj Aszú* wines based on their added sugar contents using NIRs with the appropriate chemometric tools. This can be adopted for quality assurance purposes in wines of similar quality.

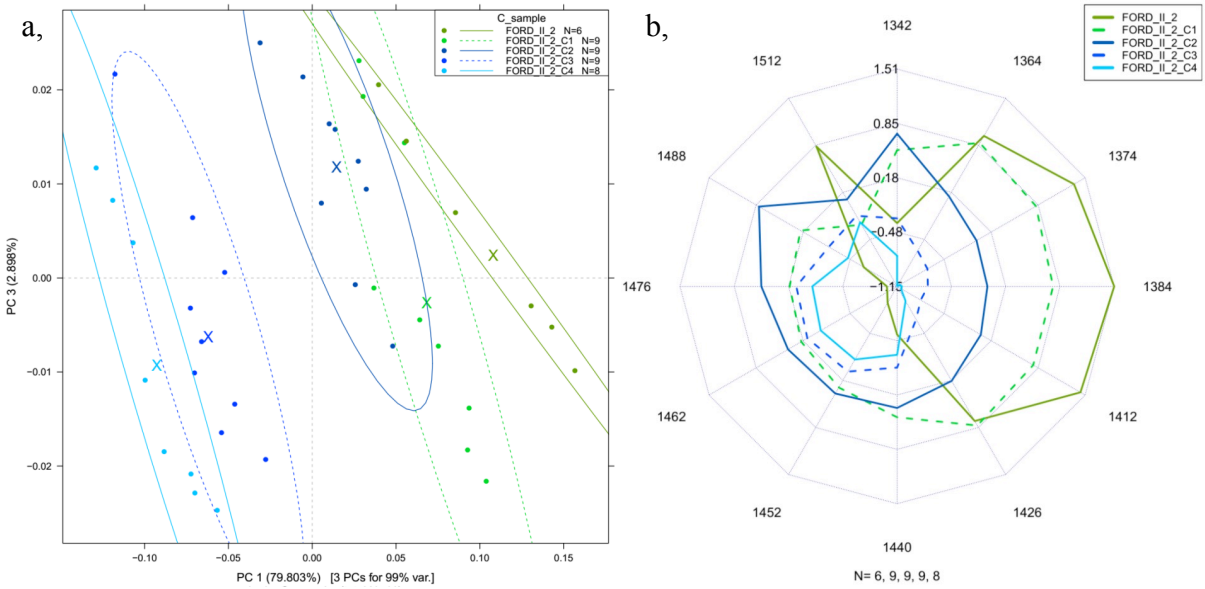

Figure 1. a, PCA, and b, aquagram plots for Ford_II_2 and adulterated Ford_II_2 wine samples using the Metri NIR spectrometer (benchtop spectrometer)

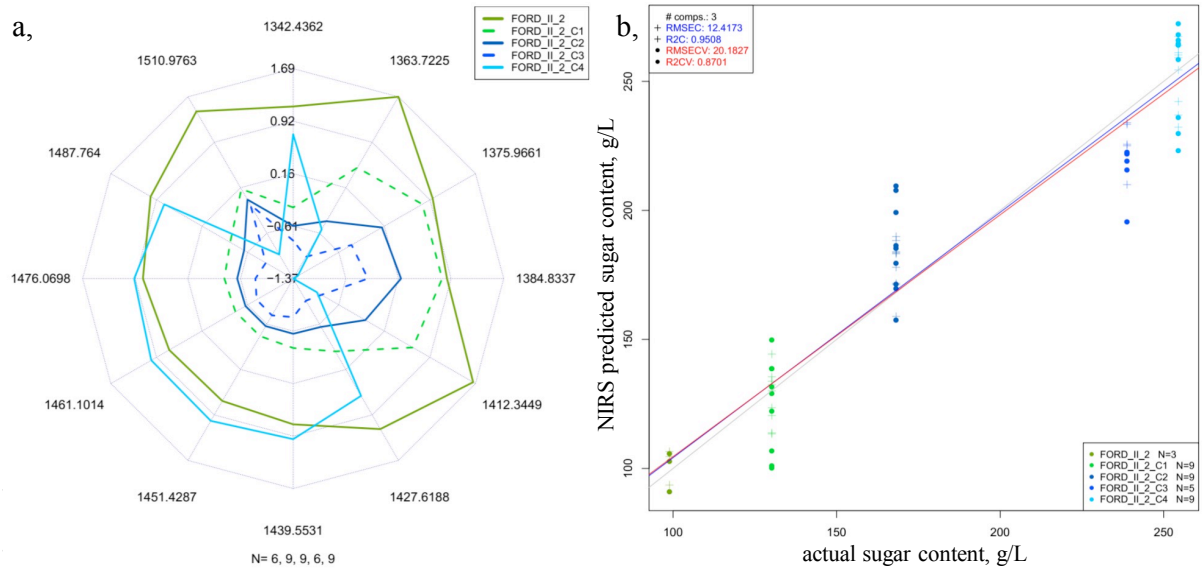

Figure 2. a, Aquagram, and b, PLSR plots for Ford_II_2 and adulterated Ford_II_2 wine samples using the NIRscan Nano spectrometer (handheld spectrometer)

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