Comparative analysis of sugars in syrups of agave, corn and honey


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ABSTRACT
The syrup of Agave is a sweet substance, produced for the hydrolysis of fructans. And know their sugars content is useful for evaluation its purity and quality. In this job, were evaluated the sugars in the syrup of A. tequilana elaborated in CEPROBI, compared with others syrups of agave, corn and honey. The carbohydrates in the syrup of A. tequilana elaborated in CEPROBI (Syrup T1) and in the comerciales syrups of A. tequilana (Syrup T2), corn (Syrup M) and honey of bee (Honey), were identified for TLC and FT-IR. Also were quantified their sugars by spectroscopy and °Brix with a refractometer. The standars used were fructose, glucose, maltose and sucrose. In the syrup T1, T2 and honey were observed fructose and glucose, addition in T1 and honey, was observed sucrose; meanwhile, the syrup M had the presence of glucose, sucrose, maltose and other sugars not studied. Also through FT-IR appear bands in the region between 1408 cm\(^{-1}\) and 775 cm\(^{-1}\), particularly specific of functionals groups of carbohydrates and were obtained characteristics peaks for sucrose to 918 and 977 cm\(^{-1}\), glucose to 1016 cm\(^{-1}\) in the syrups T1, T2, M and honey. Additionally T1, T2 and honey presented fructose to 1050 cm\(^{-1}\). Moreover the analyse of sugars content for syrup T1 in agreement to NMX-FF-110-SCFI-2008, satisfy with % of reducing sugars (90 %), fructose (82 %) glucose (17 %) required; however the syrup T2, of similar source, not satisfy with this requirements. Although, the °Brix is in the allowed interval. Concluding than the fructose is the sugar principal of syrup A. tequilana elaborated in CEPROBI, followed of glucose and sucrose. Also its content is similar to the comerciales syrups and honey.

Keywords: Agave, sugars, syrup, TLC, FT-IR.

INTRODUCTION
The Agave tequilana Weber var. Blue is the most important crop in Mexico, mainly because it is the raw material for the production of tequila; because their main source of carbohydrate reserves (fructans), which are composed of a high content of fructose chains with lesser amounts of glucose molecules (Mancilla and López, 2006). Further according to scientific studies have shown that this crop has beneficial effects on health (Mellado and López, 2013). And An alternative use of this plant is the production of agave syrup, which can compete in the market with other commercial syrups (Rendon et al. 2007; Mellado and López, 2013). For this it is necessary to know its composition and quality assessment according to the NMX-FF-110-SCFI-2008 (Mellado and López, 2013). And also, it is

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important to implement rapid analytical techniques to detect different types of sugars such as glucose, fructose and sucrose (Kelly et al. 2005; Mellado and López, 2013).

METHODS
Thin-layer chromatography (TLC)
Were applied 3 µL of aqueous solutions of each sample (syrup T1, Syrup T2, Syrup M and Honey) (3 mg / mL) to the plates of silica gel with aluminum support. TLC plates were developed in a solvent system of butanol / propanol / water and the presence of carbohydrate was detected with an aniline / diphenylamine / acetone/ phosphoric acid (Mancilla and López, 2006).

Spectroscopy FT-IR
Was used for this analysis an equipment FT-IR with the following scan parameters: Measurement mode in% Transmittance, No of Scans: 20, resolution 4 cm⁻¹ in a range of 600-4000 cm⁻¹.

Determination of sugars total, reducing and fructose
The determinations were carried according to the method of Ting (1956). To this 2.5 mL of a diluted solution was used for each sample (syrup T1, Syrup T2, syrup M and Honey), exposed to boiling for 20 min and the sugars were quantified in a spectrophotometer at a wavelength of 515 nm, using A standard curve of fructose and glucose. However, for the determination of fructose temperature conditions and reaction time (55 ° C, 30 min) were modified.

°Brix
Brix content was determined according to standards NMX Mexicana (2008), placing a drop of each sample on a portable refractometer with scale 60-90 °Brix.

RESULTS AND DISCUSSION
The conditions tested for TLC indicated a retention time (Rf) and a specific color for each standard: fructose and glucose with Rf of 0.79 and a brown and blue color band respectively; sucrose with Rf of 0.76 and brown band, maltose with Rf of 0.71 and blue band (Figure 1).

Figure 1. Thin layer chromatography of syrup and honey.

The carbohydrate identified in syrup T1 were: fructose, glucose and sucrose; whereas for syrup T2 were observed the presence of fructose and glucose only. This result agrees with that reported by Rendon et al. 2007; Mellado and López, 2013; in syrup Agave tequilana
Weber var. Blue, where have a greater presence of fructose and concentration lower of glucose and sucrose, due to its chemical composition (Mancilla and López, 2006); moreover in honey were identified fructose, glucose and sucrose, coinciding with Mellado and López (2013) in the two first mentioned sugars, except for the presence of sucrose and other sugars absents in our sample. Regarding corn syrup was detected glucose, sucrose, maltose and other molecules with different Rf (0.62, 0.55, 0.46 and 0.38) compared to standards used. Coinciding with that reported by Mellado and López, (2013) for corn syrup, where they identified the presence of glucose and maltoligosaccharides, with the exception of the presence of sucrose.

In Figure 2, appear the spectra of the various syrups and honey. Where it was observed that all the samples have a band at 3304 cm\(^{-1}\), due to stretching vibration of functional group OH characteristic of carbohydrates (Gallardo et al. 2009; Rios, 2010); and also, the presence of a band at 2929 cm\(^{-1}\) indicating the stretching of functional group CH. Also a small band found at 1099 cm \(-1\) corresponding to stretching C-O of C-O-C group which is present in the glycosidic bond of saccharose (Garcia et al. 2009) and was observed bands at 977 and 918 cm\(^{-1}\) indicating the C-H bending of the disaccharide sucrose; also the presence of a band at 1016 cm\(^{-1}\) which is representative of glucose. However, solely for the T1, T2 and honey syrup was observed a band at 1050 cm\(^{-1}\), indicating the presence of fructose (Rios, 2010). These bands, coincides with that reported for the principal functional groups of carbohydrates: 775, 918, 1024, 1047, 1099, 1253, 1344, and 1408 cm\(^{-1}\) (Rios, 2010).

In the analyses of sugars content (Table 1) in agreement to NMX-FF-110-SCFI-2008, the syrup T1 satisfies with % of reducing sugars (90 %), fructose (82 %) glucose (17 %) required. And a high fructose in syrups, is a determining factor in assessing the quality of syrups (López et al. 2003). However the syrup T2 of similar source, not satisfy with the requirements; because its content in glucose (31 %) is greater than the accepted for norm. However, the °Brix content for all the syrups is within the permitted (74 °Brix).

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>°BRIX</th>
<th>TOTAL SUGARS (g/25 mL sample)</th>
<th>REDUCING SUGARS (g/25 mL sample)</th>
<th>FRUCTOSE (g/25 mL sample)</th>
<th>GLUCOSE (g/25 mL sample)</th>
<th>SUCROSE (g/25 mL sample)</th>
</tr>
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<tbody>
<tr>
<td>Honey</td>
<td>81.5</td>
<td>142.526</td>
<td>127.726</td>
<td>90.173</td>
<td>52.353</td>
<td>14.060</td>
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<tr>
<td>Syrup T1</td>
<td>74.0</td>
<td>114.644</td>
<td>103.56</td>
<td>94.082</td>
<td>20.562</td>
<td>13.573</td>
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<tr>
<td>Syrup T2</td>
<td>77.0</td>
<td>141.659</td>
<td>117.131</td>
<td>98.268</td>
<td>43.390</td>
<td>23.301</td>
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<tr>
<td>Syrup M</td>
<td>75.5</td>
<td>67.750</td>
<td>61.214</td>
<td>9.898</td>
<td>57.852</td>
<td>6.2092</td>
</tr>
</tbody>
</table>
CONCLUSIONS
The fructose is the sugar principal of syrup *A. tequilana* elaborated in CEPROBI, followed of glucose and sucrose. Also its content is similar to the commerciales syrups and honey.

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