Research Article
Aromatic Composition of “Sodabi”, a Traditional Liquor of Fermented Oil Palm Wine

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Abstract: The aim of this study is to determine the profile of the volatile chemical compounds of Sodabi which is a traditional liquor widely consumed by people in the West Africa. Sodabi is a distilled product of fermented oil palm wine and its production is artisanal, using rudimentary equipment and recycled materials under precarious sanitary conditions. The production of this liquor is also often associated with adulterating practices such as the use of substrates other than palm wine and additives susceptible of producing toxic compounds in the end product. Chemical analysis of some samples of Sodabi showed a pH of 4.25±0.72; an acidity of 660±29.39 mg/L; a density of 0.9625±0.01; an alcohol content of 44.31±1.95%v/v and a soluble solid content of 31.45±2.44 mg/L. Volatile components of Sodabi samples were analyzed by gas chromatography-mass spectrometry and the results revealed forty-eight (48) components. The most abundant molecules was ethanol (98.95%v/v) and higher alcohols including 3-methylbutan-1-ol and 2-methylbutan-1-ol. Esters (methyl salicylate, diethyl succinate), aldehydes (furfural), ketones (butyrolactone) and phenols (phenol, 4-vinyl-2-methoxyphenol) were also determined. The compounds found in Sodabi were for the most part similar to those of industrial spirits. Trace amounts of methanol and lead were detected but the quantities of which were well below those associated with acute toxicity and representing no threat to the consumption of Sodabi.

Keywords: Aromatic profile, craft distillation, local spirit, oil palm wine, sodabi

INTRODUCTION

The production and consumption of alcoholic beverages have been omnipresent activities in the life and culture of many traditional societies around the world for centuries (McGovern, 2009). In West Africa, there is a traditional liquor called Sodabi in Togo and Benin, Akpeteshie in Ghana and Ogogoro in Nigeria. It is produced by the distillation of fermented sap of oil palm (Elaeis guineensis) or raphia palm (Raphia hookeri). In Togo, the use of Sodabi is widespread and deeply rooted in the dietary and cultural habits of the population.

Formerly limited to rural areas and reserved for adults, Sodabi has now reached urban areas and its consumption is widespread regardless of age, gender or social class. It is used in celebrations of happy as well as unhappy events and in traditional and religious ceremonies. It is the unavoidable drink of communion serving as a bridge between the material and immaterial worlds in traditional libations and rites (Oshodin, 1995). It is also used as maceration solvent in many traditional therapeutic potions and provides substantial income to producers. It therefore plays an important socio-economic role in traditional societies. Although the ban on the production of Sodabi in Togo has now been lifted, clandestine distilleries often in the bush have continued to operate. The production facilities are rudimentary and very simple. The environment and production conditions are precarious.

The quality of the end product and its alcohol content remain uncontrolled. The low price of Sodabi compared to that of imported spirits has favored trade in this traditional spirit which is today very lucrative and flourishing with its own distribution network. The commercial success of this liquor has spawned unorthodox production and sometimes fraudulent practices such as the use of raw materials other than palm wine, the introduction into the drink of foreign ingredients or additives (roots, leaves, bark, herbs) for flavoring and coloring or to give the product artificial medicinal properties or qualities that it doesn’t naturally

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possess and the addition of foreign spirits to increase the alcohol content. Some of the consequences of these fraudulent practices are harmful to consumer health and constitute a public health hazard. *Sodabi* is therefore assigned to artisanal spirits that are sometimes illicitly produced. They are reputed to contain toxic substances or impurities such as methanol and disinfectants (Rehm *et al.*, 2010) that may result in adverse health and social consequences (Lachenmeier *et al.*, 2009; Leitz *et al.*, 2009). Unlike imported modern spirits, the complete chemical composition of *Sodabi* is still studied and remains unknown. Publications have focused on the mode, the social determinants and consequences of consumption of the local alcohol (Dumbili, 2013).

Other works have studied the chemical characteristics (Ejim *et al.*, 2007; Adeleke and Abiodun, 2010; Zakpaa *et al.*, 2010). By contrast, few are works like those of Odeyemi (1980) and Ejim *et al.* (2007) that have pushed their investigations to the point of determining the volatile and non-volatile chemical compounds of *Ogogoro* obtained from raphia palm (*Raphia hookeri*).

The main objective of this study is to characterize the *Sodabi* produced from palm wine by determining the profile of the volatile chemical compounds for a better and updated knowledge of its chemical composition. This analytical profile will also assess the potential harmfulness of the drink.

**MATERIALS AND METHODS**

**Sample collection:** To better identify the different steps and operations of the artisanal production of this local spirit, we carefully monitored its preparation from March 12, 2014 to October 13, 2016 and took samples from 20 producers in different important producing areas in the Maritime and Plateaux regions of Togo. *Sodabi* production tests were also conducted in the laboratory. The *Sodabi* samples to be tested were put in 250 mL flasks which were hermetically sealed and stored in a refrigerator at 7°C until analysis.

**Chemical analyses:** Chemical analyses were conducted on twenty-five *Sodabi* samples. Total soluble solids were determined using a refractometer (Euromex HC type 0-32, Holland). The pH was measured with an electronic pH meter (WTW type pH 330i) and acidity estimated by titration with 0.1N sodium carbonate using phenolphthalein as indicator. The density and alcohol contents were measured by pycnometer (AOAC, 1990). An Atomic Mass Spectrometer (AAS) was used to determine the levels of copper and lead in the samples.

**Analysis of volatile compounds by Gas Chromatography (GC) coupled with mass spectrometry:** GC separation is a method of analysis which is applicable to gaseous compounds or compounds that can be vaporized by heating without decomposition (Tranchant and Arpino, 1995). Volatile molecules of *Sodabi* extracts were identified and quantified using a gas chromatograph type HP 6890 (Series GC System, Agilent J and W GC Columns) coupled with a Mass Spectrometer (MS) Agilent 7890A (GC system, 5975C inert XLEI/CI MSD with Triple Axis Detector). The latter was equipped with an ion trap analyzer that allows the ionization of molecules both in Electronic Impact mode (EI) and in Chemical Ionization (CI) mode and to analyze the mass spectra by ion current. Analysis by GC/MS coupling is generally used to access the mass spectra of the various constituents which are then compared to the spectra listed in reference libraries (Jennings and Shibamoto, 1980; König *et al.*, 2001).

Identification and quantification of volatile compounds in GC/MS: Identification of each volatile compound was performed by comparing the mass spectrum obtained to those recorded by the same equipment and contained in a database. The presence of each volatile compound identified by MS, was determined by a retention index (Ir) calculated from a range of alkanes or rarely from linear methyl esters at constant temperature: Kovats index (Kovats, 1965) or temperature programming (Van Den Dool and Kratz, 1963). Polar and non-polar retention indices were compared with those of authentic samples in reference libraries developed in the laboratory, in commercial libraries (Jennings and Shibamoto, 1980; König *et al.*, 2001) or listed in the literature. Confirmation of the identity of the compounds was carried out by:

- Studying the mass spectrum of the compounds in electronic impact mode
- Checking the retention index in linear alkanes with existing data in the literature (Index+/-30)
- Injecting a diluted pure or synthesized standard according to Ledauphin *et al.* (2010).

The compounds for which a standard was not injected were considered only as possibly present. In each test sample, for each of the identified compounds, an area was calculated by integration and an individual calibration for each pure and authentic compound was achieved. Analysis by GC/FID was carried out in parallel in the same operating conditions for the most abundant compounds in the different samples when pure substances were available. The chosen method of quantification was external calibration.

**Sensory assessment:** A panel of 62 usual consumers completed a sensory evaluation of *Sodabi*. The test method was the attribute rate/scaling and the attributes were color, acid flavor, palm taste, palm aroma, appearance and overall acceptability.

**Statistical analysis:** Experiments were conducted on *Sodabi* samples and the results of three measures of chemical characteristic values were expressed as mean and standard deviation. The statistical analyses were
RESULTS AND DISCUSSION

The Sodabi production process: The monitoring of Sodabi production among 20 producers in different regions made it possible to identify the different methods and stages of artisanal production of Sodabi. The techniques of distillation remain the same and similar to those of industrial production but using rudimentary materials. Spontaneous fermentation of palm tree sap is the widely used method, but this gradually gives way to other practices because of palm wine shortage. The collection of sap begins with felling by uprooting the oil palm tree. A notch is made on the upper part of the spathe below the branches. The sweet white sap is collected during one month depending on the size or variety of oil palm tree. Fermentation is spontaneous and occurs in barrels or pots for 6-8 days to transform the sugar in the sap into alcohol. The palm wine obtained from spontaneous fermentation undergoes distillation. The still consists of recovery drums as boiler and copper tubing serving as a coil as the distillate. The alcohol level varies from one distiller, who uses either the fire test on the liquid coming directly from the tip of the coil or the taste of the distillate. The end of distillation is determined by the skill of the distiller, who uses either the fire test on the liquid coming directly from the tip of the coil or the taste of the distillate. The alcohol level varies from one producer to another and is higher at the beginning of the distillation. The Sodabi recovered is stored in drums or sold directly to buyers who resell to individuals at the point of sale generally called "white curtains". Illegal practices observed at the places of production are: the addition of industrial ethanol (alcohol at 95 %vol) at the time of the first distillation. The adulterated Sodabi would be obtained by mixing in empirical proportions, real Sodabi with sugar cane alcohol or soaking the soft inner parts of the oil palm tree in industrial ethanol for a time to extract the aroma. These types of Sodabi are devoid of specific organoleptic characteristics found in real Sodabi. The artificial Sodabi would also be made by the fermentation of sugar in the presence of chemical leavens and a small amount of palm wine.

Chemical characteristics: The results of the chemical characteristics are presented in Table 1. The alcohol content was 44.31±1.95%vol. This degree was in the range of values (30-60%vol.) recorded by Oladeinde et al. (2002) and Ohimain et al. (2012) on Ogogoro, however it was greater than the values obtained by Zakpaa et al. (2010) on Akpeteshie (20.5 to 20.8%vol.), Obot (2000) (40%vol.), Adeleke and Abiodun (2010) and Ejim et al. (2007) (32.2-42.6%vol.) on Ogogoro obtained from palm wine or raphia palm. The variability in alcohol contents is related to the type of distillate (first, second or third distillate) or dilution with water. The Sodabi had a density of 0.9625±0.01 comparable to that recorded (0.9897) by Adeleke and Abiodun (2010) on Ogogoro. It had a pH = 4.25±0.72 and appeared more acidic than Ogogoro (pH = 6.3) (Adeleke and Abiodun, 2010) and Akpeteshie (pH = 5) (Zakpaa et al., 2010). The latter authors showed that during storage, the pH of Akpeteshie could decrease to 2.0 with a gradual appearance of acetic acid in the beverage. The soluble solid content of 31.45±2.74 mg/L would be due to mineral salts from contamination of the Sodabi by the distillation apparatus and/or the water sometimes used to dilute it (Ejim et al., 2007). Methanol is the substance most often associated with the toxicity of distilled spirits. The Sodabi had a methanol content of 28.65±7.34 mg/L greater than (10 mg/L) registered by Zakpaa et al. (2010) on Akpeteshie but lower (between 40 and 310 mg/L) than registered by Adeleke and Abiodun (2010) on Ogogoro. Although a certain amount of methanol was detected in all samples of Sodabi analyzed, the quantities did not exceed the maximum acceptable levels in spirits which is 10000 mg/L for the European Union countries (European Council, 1989) or 50 000 mg/L according to Paine and Davan (2001). This methanol would come from pectic substances of the wines or musts distilled and products of fermentative metabolism and non-enzymatic reactions initiated by heating (Scriban, 1985). The copper content of the Sodabi was 7.47±1.25 mg/L and this content exceeded the standard of 2 mg/L specified by WHO (2006) for drinking water. On the contrary, Akpeteshie had a higher copper content (12.615 mg/L) (Zakpaa et al., 2010) and that of Ogogoro ranged between 0.11 and 3.7 mg/L (Ejim et al., 2007). The copper concentrations may eventually be attributed to the dilution water and/or the copper coil used in distillation which is often oxidized into copper oxide by vapors and carbon dioxide. The work done by Tompsett (1992) reported a daily copper requirement per person of about 0.6 mg/L. The amount of copper contained in the Sodabi was above the threshold and may be detrimental to the health of the consumer. The Sodabi had a lead content of 0.03±0.01 mg/L which was three times higher than the standard (0.01 mg/L) specified for drinking water (European Council, 1988; WHO, 2006). Ejim et al. (2007) found 5 mg/L in one of the five samples of Ogogoro analyzed in Nigeria. Given that ions are in general non-volatile, most minerals found in the liquor could be derived from the water.
### Table 1: Chemical characteristics of Sodabi

<table>
<thead>
<tr>
<th>pH</th>
<th>Density (g/mL)</th>
<th>Alcohol content (% vol.)</th>
<th>Acidity (mg/L)</th>
<th>Methanol (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.25±0.72</td>
<td>0.962±0.01</td>
<td>44.31±1.95</td>
<td>660±29.39</td>
<td>28.65±7.34</td>
</tr>
<tr>
<td>Soluble solids (mg/L)</td>
<td>31.47±2.74</td>
<td>Copper (mg/L)</td>
<td>Lead (mg/L)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.47±1.25</td>
<td>0.03±0.01</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: Volatile compounds identified in the Sodabi samples by CPG/SM

<table>
<thead>
<tr>
<th>Compounds</th>
<th>RI a</th>
<th>RI b</th>
<th>Rt (min)</th>
<th>EI %</th>
<th>Compounds Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Esters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl formate</td>
<td>665</td>
<td>547</td>
<td>2.043</td>
<td>31-(100)-45-(40)-59-(24)</td>
<td>59</td>
</tr>
<tr>
<td>Ethyl lactate</td>
<td>814</td>
<td>613</td>
<td>4.04</td>
<td>50-(100)-29-(20)-27-(12)</td>
<td>80 x</td>
</tr>
<tr>
<td>Isoamylacetate</td>
<td>878</td>
<td>877</td>
<td>5.214</td>
<td>70-(100)-55-(83)-61-(28)</td>
<td>83 x</td>
</tr>
<tr>
<td>Ethyl-2-hydroxyisovalerate</td>
<td>967</td>
<td>849</td>
<td>7.066</td>
<td>73-(100)-76-(30)-55-(20)</td>
<td>64</td>
</tr>
<tr>
<td>Pentanoic acid-2-hydroxy-4-methyl, ethyl ester</td>
<td>1058</td>
<td>/</td>
<td>9.044</td>
<td>69-(100)-87-(88)-43-(70)</td>
<td>90</td>
</tr>
<tr>
<td>2-hydroxyethylhexanoate</td>
<td>1059</td>
<td>997</td>
<td>9.064</td>
<td>69-(100)-41-(66)-87-(54)</td>
<td>72</td>
</tr>
<tr>
<td>Isopentylmethylene</td>
<td>1069</td>
<td>/</td>
<td>9.281</td>
<td>45-(100)-70-(40)-55-(18)</td>
<td>55</td>
</tr>
<tr>
<td>Diethylnonate</td>
<td>1118</td>
<td>1167</td>
<td>11.675</td>
<td>101-(100)-129-(42)-55-(30)</td>
<td>83</td>
</tr>
<tr>
<td>Methyl salicylate</td>
<td>1194</td>
<td>1190</td>
<td>11.97</td>
<td>120-(100)-92-(54)-152-(48)</td>
<td>94</td>
</tr>
<tr>
<td>Ethyl octanoate</td>
<td>1196</td>
<td>1199</td>
<td>12.007</td>
<td>88-(100)-101-(101)-36-(57)</td>
<td>98 x</td>
</tr>
<tr>
<td>Phenylethylacetate</td>
<td>1256</td>
<td>1256</td>
<td>13.222</td>
<td>104-(100)-43-(85)-91-(22)</td>
<td>78 x</td>
</tr>
<tr>
<td>Ethyl beta phenylpropionate</td>
<td>1350</td>
<td>1390</td>
<td>15.051</td>
<td>104-(100)-91-(60)-107-(40)</td>
<td>89</td>
</tr>
<tr>
<td>Ethyl decanoate</td>
<td>1395</td>
<td>1397</td>
<td>15.983</td>
<td>88-(100)-101-(101)-44-(41)</td>
<td>98 x</td>
</tr>
<tr>
<td>1.2-benzedecarboxylic acid bis 2 (methylpropyl ester)</td>
<td>1871</td>
<td>/</td>
<td>23.684</td>
<td>149-(100)-57-(30)-41-(20)</td>
<td>90</td>
</tr>
<tr>
<td><strong>Acids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethanol</td>
<td>630</td>
<td>688</td>
<td>1.58</td>
<td>31-(100)-56-(74)-47-(20)</td>
<td>90 x</td>
</tr>
<tr>
<td>3-methyl butan-1-ol</td>
<td>741</td>
<td>737</td>
<td>3.01</td>
<td>55-(100)-42-(88)-41-(84)</td>
<td>78 x</td>
</tr>
<tr>
<td>2-methyl butan-1-ol</td>
<td>743</td>
<td>739</td>
<td>3.046</td>
<td>57-(100)-56-(84)-41-(68)</td>
<td>72 x</td>
</tr>
<tr>
<td>2-methyl propan-1-ol</td>
<td>688</td>
<td>/</td>
<td>2.33</td>
<td>43-(100)-41-(84)-42-(54)</td>
<td>50</td>
</tr>
<tr>
<td>2.3 butanediol</td>
<td>806</td>
<td>769</td>
<td>3.887</td>
<td>45-(100)-43-(15)-29-(10)</td>
<td>90</td>
</tr>
<tr>
<td>2,3 dimethyl-4-heptanol</td>
<td>1066</td>
<td>/</td>
<td>9.206</td>
<td>87-(100)-45-(59)-43-(30)</td>
<td>47</td>
</tr>
<tr>
<td>2-phenyl-2-propan-1-ol</td>
<td>1085</td>
<td>/</td>
<td>9.638</td>
<td>41-(100)-121-(54)-45-(18)</td>
<td>90</td>
</tr>
<tr>
<td>2-phenoylethanol</td>
<td>1116</td>
<td>1116</td>
<td>10.31</td>
<td>91-(100)-92-(80)-122-(24)</td>
<td>94 x</td>
</tr>
<tr>
<td>2-benzothiazole</td>
<td>1224</td>
<td>1221</td>
<td>12.565</td>
<td>135-(100)-108-(34)-69-(20)</td>
<td>94</td>
</tr>
<tr>
<td>1-benzazole</td>
<td>1293</td>
<td>1067</td>
<td>13.962</td>
<td>117-(100)-90-(42)-89-(24)</td>
<td>87</td>
</tr>
<tr>
<td>Methyleneiclon</td>
<td>1405</td>
<td>1410</td>
<td>16.083</td>
<td>178-(100)-91-(52)-103-(39)</td>
<td>95</td>
</tr>
<tr>
<td>Estragole</td>
<td>1198</td>
<td>1195</td>
<td>12.051</td>
<td>148-(100)-147-(52)-117-(30)</td>
<td>93</td>
</tr>
<tr>
<td>Methionol or 3-methylthiopropanol</td>
<td>981</td>
<td>978</td>
<td>7.368</td>
<td>61-(100)-106-(92)-30-(86)</td>
<td>97</td>
</tr>
<tr>
<td>Ethylbenzene or styrol</td>
<td>903</td>
<td>890</td>
<td>5.693</td>
<td>104-(100)-103-(44)-76-(32)</td>
<td>94</td>
</tr>
<tr>
<td>Methanol</td>
<td>/</td>
<td>/</td>
<td>3.484</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- **RI a** Calculated Retention Index using a mixture of linear aliphatic alkanes (C5-C30) according to Van Den Dool and Kratz (1963); **RI b**: Retention Index according to Ledauphin et al. (2010); **Rt**: Retention time; **EI**: Main fragments found in the mass spectrum produced in Electronic Impact mode with their respective intensities in parentheses; **% Compound**: Percentage of compounds detected by GC-FID; **Standard**: Compound for which a pure or diluted synthesized standard could be injected in the same analytical conditions of analysis.

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used for dilution. Contamination by minerals may also be due to the equipment used. For example, during the production of moonshine in the United States, leaching that occurs during mixing in containers containing lead caused lead contamination of moonshine (Lachenmeier et al., 2007).

The volatile compounds of Sodabi: The aromatic characteristics of Sodabi are presented in Table 2. A total of 48 volatile compounds were identified in the Sodabi samples analyzed against four determined by Odeyemi (1980) and a dozen by Ejim et al. (2007) in Ogogoro. Apart from ethanol (98.95%), the most abundant molecules were esters (20 compounds), alcohols (14 compounds), acids (6 compounds), carbonyl (4 compounds) and volatile phenols (2 compounds). However a terpene compound was also detected. The volatile compounds found in Sodabi (Fig. 1) belong mainly to four chemical classes:

Ester compounds: Esters were found in large amounts in all Sodabi samples analyzed. Among them, ethyl lactate, ethyl-9-hexadecenoate, isoamylacetate, phenylethylacetate, ethyl acetate, methyl salicylate and diethyl succinate represented the majority of these esters. Prior work (Ejim et al., 2007) detected ethyl lactate and acetate in artisanal spirits in Nigeria. These compounds are supposed to be derived from the acetylation (esterification with acetic acid) of the corresponding alcohol molecules by acetyltransferases as Lilly et al. (2000) reported. Esters are the main volatile compounds in wines and spirits after ethanol (Valappil et al., 2009). They are characterized by a very strong presence of ethyl acetate which alone may represent between 55 and 90% of total ester (Lilly et al., 2000; Xu et al., 2006). Depending on the nature of the lactic acid bacteria involved in malolactic fermentation, the volatile composition can be very different (Pozo-Bayon et al., 2005). Ethyl lactate ester is primarily formed by lactic acid bacteria due to the accumulation of lactic acid during fermentation (Nedovic et al., 2000; Sumby et al., 2010). Diethyl succinate (dimethylbutanedioate) is directly related to succinic acid formation that can appear during alcoholic fermentation or by the action of lactic acid bacteria on substrates such as citric or malic acid. The quantities of products are low and thus make a small contribution to the aromatic mix of the product (Lilly et al., 2000).

Higher alcohols: 3-methylbutan-1-ol, 2-methylbutan-1-ol, 2-phenylethanol, methyleugenol, 2-phenyl-2-propan-1-ol and estragole were the most important higher alcohols in Sodabi. Our results were in agreement with those of Ejim et al. (2007) for the first three abovementioned compounds were also detected in Ogogoro. The concentrations of these alcohols

Fig. 1: Chromatogram of volatile compounds detected in one Sodabisample

1) 3-methyl butanol; 2) Furfural; 3) 2-methyl butanol; 4) 2-hydroxy ethylhexanoate; 5) 2-phenylethanol; 6) Ethyl decanoate; 7) Ethyl-9-hexadecenoate; 8) Ethyl palmitate
increases steadily during alcoholic fermentation in cider and other distilled wines. These compounds are known to be derived from yeast activity by the metabolism of sugars as well as amino acids such as threonine, valine, leucine and isoleucine (Lambrechts and Pretorius, 2000). They are also known to be important precursors of esters (Pinho et al., 2006). Since the production of higher alcohols is obviously an individual characteristic of yeast strains (Giudici et al., 1990), differences in volatile composition and more particularly in higher alcohols were noted by the authors according to the strains seeded in the wine. The degradation of sugars by yeast leads in the majority of cases to the production of ethanol and other higher alcohols. Herrero et al. (1999) showed that its concentration increased sharply midway in alcoholic fermentation effected exclusively by Saccharomyces cerevisiae. 3-methylbutanol which represents approximately 80% of isopentanols (2- and 3-methylbutanol) in wines and spirits (Schumacher et al., 1998) is likely to come largely from leucine through the formation of 3-methylbutanal. Similarly, 2-methylbutanol may result from the conversion of isoleucine, isobutanol from valine and propan-1-ol from threonine (Lambrechts and Pretorius, 2000). 2-phenylethanol which is strictly speaking not a higher alcohol but an aromatic alcohol is present from the initial fermentation phase (Vidrih and Hribar, 1999). It is generally considered, in fermented beverages, as obtained from the processing of phenylalanine via phenylethanal formation (Lambrechts and Pretorius, 2000). 2-phenylethanol and methionol are classified with higher alcohols because of their possibly identical origin. Indeed, they can also come from the degradation of two amino acids: phenylalanine and methionine (Lambrechts and Pretorius, 2000). 3- (methylthio) propan-1-ol and its acetate are derived from the amino acid methionine through the Ehrlich pathway (Etschmann et al., 2008). Finally it should be noted that the presence of higher alcohols and their concentration greatly influence the organoleptic properties of the product, causing a rather unpleasant solvent-like taste (Williams, 1974). The diacetyl and 2,3-pentanedione are secondary products of the synthesis of amino acids (valine and isoleucine) in yeast. At the end of fermentation, yeast are capable of reducing both compounds to acetoin and 2,3-butanediol (Herrero et al., 2003).

**Carboxylic acids:** The best markers of malolactic fermentation of distilled wine seem to be mostly carboxylic acids and derivatives of organic acids. Acetic acid, propanoic acid, 2-methylpropanoic acid (isobutyric acid), 2-methyl butanoic, hexanoic and octanoic were also found in the Sodabi. In general, the carbonyl compounds are derived from the decarboxylation of α-keto acids (or oxo-acids) and the oxidation of alcohols. Their olfactory perception threshold is generally low and most are regarded as providing rather unpleasant flavors (Williams, 1974).

**Phenolic compounds:** 2-methoxy-4-vinylphenol and phenol were both volatile phenols detected in Sodabi. In spirits, several types of microorganisms appear to be at the origin of the appearance of volatile phenols. Collenoid Lactobacillus (bacteria) and Brettanomyces anomal (yeast) are likely to produce them in large quantities (Burton et al., 2011). The presence of eugenol and 2- (4-hydroxyphenyl) ethanol is similar to that of 4-ethylphenol and 4-ethylguaïacol (Burton et al., 2011). Fermentation has a very strong impact on the production of volatile compounds. Vanbeneden et al. (2008a) reported that the concentration of 2-methox-4-vinylphenol increased in the medium at high temperatures. Phenolic compounds are undesirable when present in excessive concentrations as in the case of beer lager (Vanbeneden et al., 2008b).

**Sensory characteristic of Sodabi:** Figure 2 shows the scores given by the panelists to the main sensory characteristics of the ordinary Sodabi compared to the same rectified in the laboratory. This sensory evaluation showed that the ordinary Sodabi organoleptic characteristics were fairly well rated and therefore acceptable for consumption, however, a rectification in the laboratory produced a Sodabi with improved aroma, color, appearance and general acceptability with a reduction in the palm taste, alcohol content and acid flavor. The results of Sodabi tasting therefore showed that the rectified Sodabi was more preferred than the ordinary, however the difference in general acceptability was not significant (p> 0.05).

**CONCLUSION**

This analytical study allowed to expand the knowledge base of the chemical properties of Sodabi and to develop a better profile of the components of this local spirit produced from palm wine. This traditional alcohol was characterized by the presence of high amounts of esters, alcohols and fatty acids. Ethanol was
the most representative compound with the highest content. Most of the molecules identified were similar to those found in conventional commercial spirits. Some of the compounds are known to have a negative effect on the organoleptic properties of the beverage. No major toxic compound was found except for insignificant traces of methanol at doses that pose no serious risk of toxicity on consumption of Sodabi. The presence of certain mineral contaminants (lead and copper) at high levels may present a risk of toxicity but these pollutants can also be avoided by diluting with drinking water unpolluted by heavy metals.

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