Effect of Ultrasonic Treatment on Volatile Compounds of Grewia tenax (Forssk.) Fiori Fruit Extracts

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Abstract

Effect of ultrasonic treatment on volatile compounds of Grewia tenax. Fiori fruit extracts were investigated in the present study. Findings suggested that ultrasonic treatment could improve the quality and safety of Guddaim juice using low power 300 W and 20 kHz. More than 30 volatile compounds including alcohols, aldehydes, ketones, esters and sulfurs were detected in the Guddaim juice samples treated by low power ultrasound. In the other hand, the findings showed that the samples treated by high power detected 24 major volatile compounds. The results showed that the 1-hexanol was increased when the power was increased (1200 W, 15 min) compared with the treatment with low power (300 W, 15 min).

Keywords: Grewia tenax, Guddaim juice, ultrasonic treatment, low power, volatile compounds.

Introduction

Guddaim is the common name of Grewia tenax (Forssk.) Fiori (GT) (Family: Tiliaceae), a valuable plant species in Sudan, grown in the Arabian peninsula and in the African and Southeast Asian continents (Gebauer et al., 2007; Aboagarib et al., 2014). Grewia tenax is used as medicine to treat various diseases including jaundice and hepatic disorders (Khemiss et al., 2006), a decoction prepared from the bark is used as antihelminthic (El-Kamali and El-Khalifa, 1999) and an alcoholic extract ointment was reported to help in faster wound healing (Shrivastava et al., 2000). The fruits, roots and leaves of G. tenax were used as food while its juice and fruit decoctions have been used in Africa as thirst quenching drinks in hot weather (Kumar et al., 2008). The fruit powder is mixed with milk and consumed to accelerate bone fracture healing and to suppress swelling (Shekhwat and Batra, 2006). In addition to the fruit, bark infusions are also used in wound healing. There is a paucity of scientific evidence regarding its use for jaundice and other liver disorders. Moreover, the fruits are eaten to treat anemia and chest diseases (Al-Said et al., 2011). Ultrasound technology is considered as one of the bases of non-destructive, reliable and fast technique for connecting specific quality-related indicators and specification of fruit and vegetables with the development stages during growth and maturation, and during storage and shelf-life, until the consumption (Al-Numair et al., 2009). The new methods mostly include non-thermal food preservation technologies which provide full or partial alternatives to heat (decreasing treatment time or/and temperatures).

Including the other physical procedures, the application of foods under magnetic or electric fields, microwave, ionizing radiation, light pulses high-intensity and high pressure were investigated by various researchers (Moreno and Salvado, 2000). Ultrasound used in the food industry has been a subject of research and development for many years and as is the case of other areas, the sound ranges used can be divided into high or frequency and low or high energy. Up to a few years ago, the majority of applications and developments involved. Such information gives details, for e.g., long-term stability of fruit juices and the stability of emulsions such as mayonnaise (AOAC, 1990). Industrial interest in developing mild food preservation procedures, which could replace the severe heat-based methods commonly used are investigated at present. Often termed minimal processing, the benefits of these approaches are important aspect of current and future commercial product development. Quality attributes, which can be protected by the application of minimal process technologies, are flavor and visual appearance, i.e. color and texture, nutrition values and absence of additives. Minimal processing can be applied to a wide variety of foods including short shelf-life products such as fresh fruit and vegetables, chilled ingredients and convenience dishes through to long-life ambient stable foods such as cooked meats and vegetables. Considering the above facts in view, this study aimed to determine the effect of ultrasonic treatment on volatile compounds of Grewia tenax fruit extract. In this study, we evaluate the application of Guddaim fruit juices at different ultrasonic treatments and compared the flavor values of juices treated in different incubation times.
Materials and methods

Collection of fruits: Grewia tenax fruits were purchased from a local market at Wad Medani City, Gezira State, Sudan; the fruits were put in plastic bags and brought to the Jiangnan University, Wuxi city, People’s Republic of China.

Preparation of Guddaim fruit juice: Grewia tenax fruits were washed by tap water to get rid of any impurities or dust on their surfaces. The fruits were flooded with ionized water for 6 h, prior to juice extraction by using a household juicer (Fig. 1).

Ultrasonic treatment: Grewia tenax fruit juice (100 mL) was used for determining the effect of ultrasonic treatment. Ultrasonic generated to probe, JY98-III DN, Nanjing Fei, Qi Industry and trade Co. Ltd., Nanjing China, with minimum ultrasonic power of 300 W and maximum 1200 W at frequency of 20 kHz, equipped with an LCD digital screen monitor, thermometer, jacketed beaker volume of 100 mL and a circular water bath was used. Minimum ultrasonic power (B, C and D) and maximum ultrasonic power (B₀, C₀ and D₀) power was used with three different time durations (10, 15 and 20 min) (Fig. 1). Temperature of 30°C was controlled by immersing a glass beaker into an automatically adjustable temperature water bath (HH-2 Guohua Wiring Company, Shanghai, China).

Analysis of volatile compound by GC/MS: The volatile compounds of Grewia tenax fruit juice was investigated by headspace solid-phase microextraction (HS-SPME) combined with gas chromatography–mass spectrometry (GC/MS). About 5 mL of the juice samples were put into a 15 mL headspace vial and sealed with a PTFE-faced silicone septum. Then, an SPME fiber was exposed to the headspace while maintaining the sample at 50°C for 30 min. The fiber with compounds was retracted back into the needle and transferred to the injection port of gas chromatograph immediately. A time period of 3 min was adopted for desorption and conditioning at the desorption temperature of 250°C. GC-MS was performed using a gas chromatography–mass spectrophotometer (GC 6890/MS 5975, Agilent, USA). The compounds were separated using a DB-WAX capillary column (Supelco, USA). The juice sample was injected in split less mode. Helium was used as a carrier gas with a velocity of 0.8 mL/min. The temperature programmed was isothermal for 3 min at 40°C, raised to 90°C at a rate of 5°C/min, then raised to 230°C at a rate of 10°C/min and held for 7 min, total run time was 34 min. Injector and detector temperatures were both set at 250°C. The mass spectra were obtained using a mass selective detector working in ionization modes of EI⁺, the emission current of 80 IA, electron energy of 70 eV, scanning mass range of 33-450 m/z and detector voltage of 1000 V were employed. The interface and source temperature was 250 and 200°C respectively. Volatile compounds were tentatively identified by comparing their mass spectra with those included in the Wiley and NIST libraries (Aboagarib et al., 2016). The relative contents of flavor compounds were determined by comparing the percentage of peak areas (Xu et al., 2015).

Results and discussion

The total volatile compounds in Guddaim juice samples treated using low power ultrasonic 300 W and high power 1200 W under different incubation times of 10, 15 and 20 min are shown in Table 1 and 2 respectively. Findings suggested that ultrasonic treatment could improve the quality and safety of Guddaim juice using low power 300 W and 20 kHz. More than 30 volatile compounds including alcohols, aldehydes, ketones, esters and sulfurs were detected in the Guddaim juice samples treated by low power ultrasound. In the other hand, the findings showed that the samples treated by high power detected 24 major volatile compounds. The results showed that the 1-hexanol was increased when the power was increased (1200 W, 15 min) compared with the treatment with low power (300 W, 15 min).

Conclusion

The effect of ultrasonic treatment for quality and nutritional values of Guddaim juice were studied. Volatile components of sonicated Guddaim juice were improved especially with low power treatment of increasing time.

Fig. 1. Preparation of Guddaim fruit juice and ultrasonic treatment.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Constituent</th>
<th>Retention time (min)</th>
<th>Relative peak area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>2.</td>
<td>2-Pentanone (CAS)</td>
<td>n.d</td>
<td>4.86</td>
</tr>
<tr>
<td>8.</td>
<td>1,8-Cineole</td>
<td>10.44</td>
<td>10.61</td>
</tr>
<tr>
<td>11.</td>
<td>Gamma.-Terpinene</td>
<td>10.94</td>
<td>11.54</td>
</tr>
<tr>
<td>13.</td>
<td>Benzene, 1-methyl-3-(1-methylethyl)-</td>
<td>11.68</td>
<td>12.28</td>
</tr>
<tr>
<td>14.</td>
<td>2-Octanone (CAS)</td>
<td>12.67</td>
<td>12.88</td>
</tr>
<tr>
<td>18.</td>
<td>Nonanol</td>
<td>n.d</td>
<td>15.40</td>
</tr>
<tr>
<td>19.</td>
<td>2-Octanol</td>
<td>16.74</td>
<td>16.02</td>
</tr>
<tr>
<td>20.</td>
<td>Acetic acid</td>
<td>17.69</td>
<td>16.47</td>
</tr>
<tr>
<td>21.</td>
<td>1-Heptanol (CAS)</td>
<td>n.d</td>
<td>16.63</td>
</tr>
<tr>
<td>22.</td>
<td>Decanal (CAS)</td>
<td>n.d</td>
<td>17.28</td>
</tr>
<tr>
<td>24.</td>
<td>1-Octanol (CAS)</td>
<td>20.05</td>
<td>18.22</td>
</tr>
<tr>
<td>25.</td>
<td>2-Undecanone (CAS)</td>
<td>20.66</td>
<td>18.76</td>
</tr>
<tr>
<td>26.</td>
<td>3-Cyclohex-1-ol, 4-methyl-1-(1- methyle]</td>
<td>n.d</td>
<td>18.88</td>
</tr>
<tr>
<td>27.</td>
<td>Silanediol, dimethyl-</td>
<td>21.80</td>
<td>19.39</td>
</tr>
<tr>
<td>32.</td>
<td>2-Methyl-1-nonene-3-yne</td>
<td>n.d</td>
<td>22.16</td>
</tr>
<tr>
<td>34.</td>
<td>1,4-Cyclohexadiene-1-methanol, 4-(1- meth)</td>
<td>27</td>
<td>24.04</td>
</tr>
</tbody>
</table>

A = Control, high power 20 kHz, 300 W (B: 10 min, C: 15 min and D: 20 min). n.d: Not detected.
The findings suggest that ultrasonic treatment technology using low power could be potentially employed for the processing of Guddaim juice and could improve its quality. In the other hand, ultrasonic high power treatment decreased the nutritional values of the Guddaim juice. It may be concluded that ultrasonic treatments significantly affected the volatile compounds and improved the quality of Guddaim juice especially with low power treatment with increasing time.

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References