Effects of Ultra-high Pressure Treatment on Aroma Components of Braised Mandarin Fish

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Abstract: Ultra-high pressure technology is a new type of non-thermal food processing technology, which has the characteristics of low temperature, high quality, fast uniformity, energy saving and no pollution for food sterilization and inactivation of enzymes[1], at the same time, it is the best processing method that can keep the natural color, aroma, taste and nutrition of the food in the prior art. In this study, the effects of ultra-high pressure treatment on the aroma components of braised mandarin fish were studied. According to the experimental results, more alkanes were detected and accounted for a large proportion, which was the main substance affecting the flavor of mandarin fish.

1. Introduction

Braised mandarin fish[2] is a traditional fermented dish in ancient Huizhou. The dish is tender, spicy and fragrant, and the meat is shaped like garlic cloves. It tastes delicious when eaten, and it has been listed on the protection list of intangible cultural products in Anhui Province, by the local people and tourists love. Ultra-high pressure processing is the best processing method in the existing processing technology, which can keep the natural color, aroma, taste and nutrition of food[3]. In this experiment, the braised mandarin fish was used as the raw material and the fish without ultra-high pressure treatment as the control group, the changes of volatile components in braised mandarin fish were studied by solid phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) under different pressure (300, 400, 500 MPa, 10 min, respectively). It provides some theoretical basis for the application of ultra-high pressure technology in the processing and storage of aquatic products[4].

2. Material

Mandarin fish: Yanghu vegetable market, Huangshan City
SPME head (Polydimethylsiloxane/divinylbenzene, PDMS, DVB) with coating thickness of 65 m;
7890A / 5975C Gas chromatography-mass Spectrometer

3. Methods

3.1. Sample preparation
The smelly mandarin fish was packed in vacuum after being braised. The samples were divided into four groups. The fish samples without UHP treatment were the control group, and the other three groups were placed in the UHP chamber (high pressure medium was water) and treated under different pressure conditions (300, 400, 500 MPA), the holding time of each group was 10 min[5].

3.2. Extraction of volatile components
Smashed the braised mandarin fish, weighed 9 g fish meat, then added 21mL saturated sodium chloride solution, mixed well and poured into 50 mL headspace bottle. 65 M PDMS / DVB extraction head was selected and extracted for 50 min at 50 °C. Then the PDMS / DVB extraction head was inserted into the inlet of gas chromatograph rapidly.

3.3. Analysis by gas chromatography-mass spectrometry
CHROMATOGRAPHIC CONDITIONS: DB-5MS elastic capillary column (60m 0.32 mm 1 m), no split mode; programmed heating: Initial temperature 40 °C, held for 5 minutes, then increased to 100 °C at a rate of 3 °C/min, continue heat to 160 °C at a rate of 5 °C / min, finally increased to 250 °C at a rate of 12 °C / min, kept 3 min; The inlet temperature was 250 °C and the flow rate of carrier gas (He) was 1.0 mL / min.

MASS SPECTRUM CONDITIONS: Electron Bombardment (EI) ion source; Electron energy: 70ev[6]; Transmission Line Temperature: 280 °C; Ion source temperature: 230 °C; Quadrupole temperature : 150 °C; Mass scanning range( M / Z): 35 ~ 350[7].

4. Results and Discussion
Headspace solid-phase microextraction (HS-SPME) and GC-MS were used to analyze the volatile components of the Mandarin Fish after seven days storage. The results showed that there were 57 kinds of volatile compounds, which could be classified into aldehydes and ketones, alcohols, alkanes, olefins, lipids, aromatics and other compounds.

Table 1. Effects of ultra-high pressure treatment on the relative content of volatile compounds in the braised mandarin fish

| Aldehydes   | Hexanal | Heptanal | Retention Time / min | Unprocessed | 300 MPA | 400 MPA | 500 MPA |
|-------------|---------|----------|----------------------|-------------|---------|---------|---------|
| Octyl Aldehyde | 9.2736  | 0.5194   | 0.4465               | 2.4805      | 2.7632  |
| Nonaldehyde  | 20.8447 | 0.1236   | ND                   | ND          | ND      |
| Decanal      | 49.4940 | 0.4245   | ND                   | ND          | ND      |
| Isoamyl alcohol | 70.0178 | 1.1202   | 0.7813               | 3.1689      | ND      |
| Eucalyptol   | 77.1304 | 0.5237   | ND                   | ND          | 0.4886  |
| Linalool     | 7.2722  | ND       | ND                   | ND          | ND      |
| 4-terpene alcohol | 40.4781 | 0.9646   | 1.1803               | 3.4863      | 0.7849  |
| Hexane 2 alcohol | 71.0244 | 0.8313   | 0.6271               | 3.554       | ND      |
| 1-octene-3-ol | 75.2749 | 0.3683   | 0.2159               | 1.1508      | 0.5419  |
| Alpha-terpineol | 67.1512 | ND       | 0.1707               | 1.3145      | 0.6896  |
| Hexamethylcyclotrisiloxane | 51.1037 | ND       | ND                   | ND          | 0.5976  |
| Decylcyclopentasilane | 77.3735 | ND       | 0.195                | ND          | ND      |
| Dodecylcyclohexasiloxane | 6.1904  | 0.6976   | 13.8231              | 10.154      | 1.3218  |
| Decane       | 67.4299 | 0.2354   | 1.6101               | 0.8262      | 1.1246  |
| Heptadecane  | 78.4715 | 3.3496   | 0.3607               | 0.5936      | 0.5638  |
| Cyclohexane  | 42.8189 | 0.1639   | 2.3714               | ND          | 1.4826  |
| Compound                        | 1st Value   | 2nd Value | 3rd Value | 4th Value | 5th Value |
|--------------------------------|-------------|-----------|-----------|-----------|-----------|
| Tetradecane                    | 89.0270     | 0.445     | 0.0951    | 0.2418    | 0.245     |
| Hexadecane                     | 2.7291      | ND        | 0.1825    | ND        | ND        |
| Dodecane                       | 81.3926     | ND        | 0.4451    | ND        | 7.9778    |
| N-tridecane                    | 87.0350     | 0.1342    | ND        | ND        | 0.3834    |
| Chloroform                     | 70.9236     | ND        | 1.4614    | ND        | 11.6956   |
| 3-methyl undecane              | 77.3735     | ND        | ND        | ND        | 0.4395    |
| Octamethylcyclotetrasiloxane   | 2.9101      | ND        | ND        | 0.3496    | 0.0939    |
| 1-chlorhexane                  | 68.1254     | ND        | ND        | ND        | 0.3454    |
| Alkyl Cycloalkane              | 24.4045     | ND        | 15.3678   | 3.4126    | ND        |
| The Alkyl Cycloalkane isomer   | 10.6862     | ND        | 0.2393    | ND        | ND        |
| β-pinene                       | 2.4049      | ND        | 0.3957    | ND        | ND        |
| 2-methyl-3-phenyl-1-propene    | 2.3671      | ND        | 0.3285    | ND        | ND        |
| Diisobutene                    | 22.7327     | 0.0562    | ND        | ND        | ND        |
| Dibutylene                     | 70.7346     | 0.1226    | ND        | ND        | ND        |
| Camphene                       | 3.2828      | ND        | 2.1748    | 1.4391    | ND        |
| Cumene                         | 3.5663      | ND        | 0.484     | ND        | ND        |
| 1-terpene                      | 16.9606     | ND        | 0.2292    | 0.3359    | ND        |
| Methyl palmitate               | 18.1463     | ND        | 0.1196    | ND        | ND        |
| Disobutyl Phthalate            | 77.3681     | ND        | ND        | 0.8155    | ND        |
| Isoamyl Formate                | 92.6530     | 1.1807    | 0.1869    | 0.5899    | 0.4459    |
| p-xylene                       | 93.2122     | 13.9173   | ND        | 4.3194    | ND        |
| Methyl palmitate               | 7.2127      | ND        | ND        | 1.0184    | ND        |
| Isomers of naphthalene         | 11.9651     | 0.0738    | 14.7166   | 0.5464    | 4.4414    |
| 1,2,3-trimethylbenzene         | 74.9193     | 0.5254    | ND        | 0.3761    | 0.2392    |
| 1,3,5-trimethylbenzene         | 74.2675     | 0.3798    | ND        | ND        | ND        |
| 1,2,3,4-tetramethylbenzene     | 26.2115     | 0.0403    | ND        | ND        | ND        |
| 1,4-dihydro-1,4-methylbenzene  | 32.8775     | 0.1611    | 0.2004    | ND        | 0.42      |
| 1,2,3,5-tetramethylbenzene     | 67.6285     | 0.1       | ND        | ND        | ND        |
| 1,2-xylene                     | 81.3440     | 0.2206    | ND        | ND        | ND        |
| Ethyl Benzene                  | 67.6230     | ND        | ND        | ND        | 0.2117    |
| Hexanal                        | 14.8997     | ND        | 4.2342    | ND        | ND        |
| Heptanal                       | 11.2669     | ND        | 3.7402    | ND        | 0.8522    |

Note: The untreated group was control group, ND Indicates that it is not detected

In the unprocessed samples, the content of lipid was relatively high, but the amount of alkanes was relatively high, which was considered to be the main substance affecting the flavor of braised mandarin fish. This conclusion was consistent with that the aromatic and hydrocarbon substances mentioned by David Seaman[8] were produced by thermal degradation of fat and protein, which
contributed to the flavor formation of cooked grass carp meat. In addition, nonaldehyde has a strong fatty smell, with orange and rose notes when diluted, and decanal has sweet aldehyde and citrus aromas[9]. Both of the two substances had some effects on the flavor of the mandarin fish.

As can be seen from Figure 1, the number of alcohols remains almost constant, except for 500 MPA, which decreases with the increase of aromaticity pressure. From Figure 2, the relative content of aldehydes and ketones were the least, and the relative content of alkanes was the highest and increases with the increase of pressure except 400MPA. Figures 1 and 2 showed that the number and relative content of the compounds in the treated and untreated braised mandarin fish were the most similar and the most suitable condition.

![Figure 1. Changes of volatile compounds in the flesh of Mandarin Fish treated by ultra-high pressure](image1)

![Figure 2. Changes of volatile components in the flesh of Mandarin Fish treated by ultra-high pressure](image2)

From Table 1, it can be seen that the relative contents of the two compounds, 1-octene-3-ol and Hexanal[8], which represent the degree of freshness of the fish, also increase with the increase of the pressure, indicating that the preserved time of the stewed Mandarin fish with 500 MPA was longer, the flavor was also preserved more completely. In addition, hexanal was the basic product of linoleic acid oxidation, which had strong aroma of green, vegetable and fruit[10].

5. Summary
With the increase of pressure, the number of alcohols remained almost unchanged, and the number of aromaticity decreased except for 500 MPa. The relative contents of 1-octene-3-ol and Hexanal, which
were the index of freshness, also increased with the increase of pressure, which indicated that the preserved time of stewed mandarin fish with 500 MPa was longer, the flavor was also preserved more completely. In addition, more alkanes were detected and accounted for a large proportion, which was considered to be the main substance affecting the flavor of the red-roasted and smelly braised mandarin fish.

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