Effects of different drying methods on freshness of Pseudosciaena Crocea fillet

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Abstract: Taken Pseudosciaena Crocea fillets as experimental material, effects of three drying methods on the quality of fish fillet were compared, including hot air drying, controlled freezing-point vacuum drying and vacuum freeze drying. The result showed: when the final moisture content was set to 20%, hot air drying rate was the fastest after 8h, followed by ice temperature vacuum drying, while vacuum freeze was the slowest at 24h; K value of hot air drying was significantly higher than those of controlled freezing-point vacuum drying and vacuum freeze drying, reaching 40.24%, while the latter both remained the excellent grade (less than 10%); On the contrary, controlled freezing-point vacuum drying increased by 38mg/100g instead. From micro-organisms and TVB-N, values of three drying ways were far below the fresh and controlled freezing-point vacuum drying showed the lowest. It inferred that: the quality of fillet dealt by controlled freezing-point drying was the best.

Introduction

Pseudosciaena Crocea is one of the major commercial fish stocks in coastal areas of China. Characterized by its tender meat, delicious, low cholesterol, high protein nutritional value and health function, such as activating blood, tonifying spleen and moistening lungs, it is widely popular with domestic and foreign customers and has great development potential [1]. Due to high mortality during transport, it is necessary to search a processing way to store and keep fresh. Drying is one of the most important methods of processing and preservation techniques. Characterized by retaining the color, aroma, flavor and nutritional value, Freeze drying stands out, but its disadvantages expensive, inefficient, energy-consuming, high costs limit their development. In the 1970s, Japan scholar put forward controlled freezing-point storage technology, compared with chilled and frozen Atlantic salmon fish[2], the result showed under ice-temperature storage, cathepsin fish still remained active. Studies conducted by Guo[3] showed that the quality of green bean stored ice-temperature (at 0℃)was superior to low temperatures and room temperature. Based on the technique above, controlled freezing-point drying was raised, that's to say, the temperature of drying process is about to be maintained under the range from 0℃ to freeze-point. Ice-temperature technology not only can extend shelf life, but also accelerate the maturity and improve the taste and maintain the same flavor and color similar to the fresh after rehydration, therefore has great application potential. At present, Studies on the technology of controlled

freezing-point drying applied in aquatic products have been reported little in china ,what's more, less literatures were reported on about Crocea. Studies conducted by Li [4] on carrot showed that ice-temperature vacuum drying can achieve high quality of carrots, less Vc lost, good quality, high rehydration rate. But compared the ice temperature drying with air drying also exposed the lack of the former, long drying time[5]. In this paper, taken pseudosciaena crocea as the object, in order to shorten the drying time, ice-temperature vacuum drying technique was applied. Through indicators such as the drying rate, freshness indicator K, volatile TVB-N, total bacterial, it was compared with the hot air drying and vacuum freeze drying to lay the theoretical foundation for fish processing.

Materials and methods

Preparation of fish and experimental setting

Pseudosciaena Crocea (weight of 775 ± 225 g, the initial moisture content is 77.4%) were purchased from an aquatic product market in shanghai, China, in April 2014, and were immediately delivered to the laboratory alive. Then keep them alive morality for 1~2 h in holding pond. Fishes were euthanized by hit, scaled, gutted, deheaded, washed, take its backbone meat and cut into fillet about 1 cm in thickness.

Three kinds of drying methods were set as the following: Controlled freezing-point vaccum drying: the temperature of a constant temperature bank was set to 1℃ ; Drying chamber pressure is 1300 ~ 1400 pa, while the final water content of the fish fillet reached between 20% ~ 30%, then stop drying; Hot air drying: the drying temperature is 50℃ , wind speed is 1.5 m/s, while the final water content of the fish fillet reached between 20% ~ 30%, then stop drying; Vacuum freeze drying: precool temperature was -30℃ , plate temperature was 15℃ , parse the dry plate temperature is 20℃ , and the pressure of drying chamber was 20 pa ~ 30 pa, when residual water content of the fish fillet below 5%, then stop.

Method

Determination of the freezing point

Pseudosciaena Crocea was dug into two pieces along the spine, whose temperature was collected
and recorded by temperature acquisition instrument. Put the platinum resistance near the tail and fixed, then store in the -18℃ freezing room, collecting data every 10 seconds. After the end of the test, draw the frozen curve to determine the freezing point and the range

Determination of the moisture content

The direct drying method was applied, referring to the GB/T 5009.3-2003 of the determination of moisture content in food: weighed accurately 5g sample, placed in a covered glass container, then put in the oven at 105℃ ,open the cover. 6h later, weighed accurately.

ATP-related compounds

ATP-related compounds were determined by HPLC (Waters E 2695, Waters Corp., USA) based on the method of Yokoyama [6],with slight modifications. 5*g* of sample was homogenized with 10 ml of chilled 10% perchloric acid. The homogenate was centrifuged at 2000g for 10 min and removed the supernatant to beaker. Then the sediment was homogenized with 5 ml of chilled 5%

perchloric acid, centrifuged at the same condition. Put the supernatant to the beaker too. Then the supernatant was immediately neutralized to pH6.5 with 10 M KOH and 1M KOH. After 30 minutes' standing, the supernatant was diluted with distilled water to 50ml. The mixture was filtrated through a 0.45-μm diameter filter for subsequent analysis.

Separation of ATP-related compounds was conducted on a reverse-phase column (Inertsil ODS-SP C18, Shimadzu Corp., Japan). The mobile phase of 50 mM sodium di-hydrogen phosphate (pH 6.5) was used at a flow rate of 1 ml/min and temperature 28 ℃. The eluent was monitored at 254 nm for each ATP-related compound.

The K-value[7], a freshness index, was defined as follows:

$$\text{K value}(\%) = \frac{[\text{HxR}] + [\text{Hx}]}{[\text{ATP}] + [\text{ADP}] + [\text{AMP}] + [\text{IMP}] + [\text{HxR}] + [\text{Hx}]} \times 100\%$$

The measure of total bacteria

Based on GB4789.2-2010, determined bacterial count. Counted three gradients of two parallel samples, and take the average.

Total volatile basic nitrogen

Automatic Kjeldahl determination Analyzer was applied using semi-micro Kjeldahl method for determine the total volatile basic nitrogen content[8,9]. Mashed samples about 5g were weighed accurately and put in FOSS alimentary canal, adding light magnesium oxide about 0.5g to test. Repeated this three times and averaged

Results and discussion

Results of freezing point

The freezing point was -1.4 degree. namely its ice temperate range is from -1.4˚C to 0˚C . To enable the process of drying within the ice temperate, the temperate of vacuum devices should be strictly controlled (0~-1.0) range

Analysis of drying rates

Pseudosciaena Crocea fillets dried by three ways of drying respectively with initial moisture content 77.4%, the results of dry time and residual moisture rate were shown in Table 1.When the final moisture content was set to 20%, hot air drying rate was the fastest, just costing 8h, followed by ice temperature vacuum drying during 20h,while vacuum freeze drying was the slowest, costing about 24h.

Table 1 The comparison of residual moisture rate in *Pseudosciaena Crocea* fillets

Drying ways	The initial moisture rate(%)	Time(h)	Residual moisture Rate (%)
Vacuum freeze drying	77.4%	24	20.3
Hot air drying		8	22.1
Controlled freezing-point vaccum drying		20	21.7

Comparison of ATP and K values

Creatinine (IMP) is one of the degradation products of adenosine triphosphate (ATP), the main flavor nucleotides, also a strong umami flavor enhancer. Enhancing fresh capacity is 40 times than that of the sodium glutamate, so was widely used in food flavorings[10]. The change trend of IMP and

ATP in the fillet was shown in Figure 2-1. ATP content in the fresh fish was the highest, reaching 96.13mg/100g. Because the ATP is an important physical energy in living fish. ATP in freshly slaughtered fillets had not yet had time to break down. After drying ATP content had declined, while that of vacuum freeze drying was second to the fresh. Perhaps low temperature caused fillets to be frozen, blocking enzyme contact with substrate, had yet entered stiff period and less decomposition (only about 23%).As a result, ATP content reached 73.41mg/100g,while IMP also lost less, up 18.19%; Due to high temperature in hot air drying, ATP and associated products were degraded completely, just leaving 6.52 mg/100g. Consequently, loss ratio of both ATP and IMP were larger, reaching 93.21%, 43.42% respectively. By contrast, the IMP of controlled freezing-point vacuum drying increased by 38mg/100g instead. may be low temperature was contributed to ATP partial decomposition and cause the accumulation of IMP. It explained that the controlled freezing-point vacuum drying was superior to other methods, helping increase and maintain taste compounds.

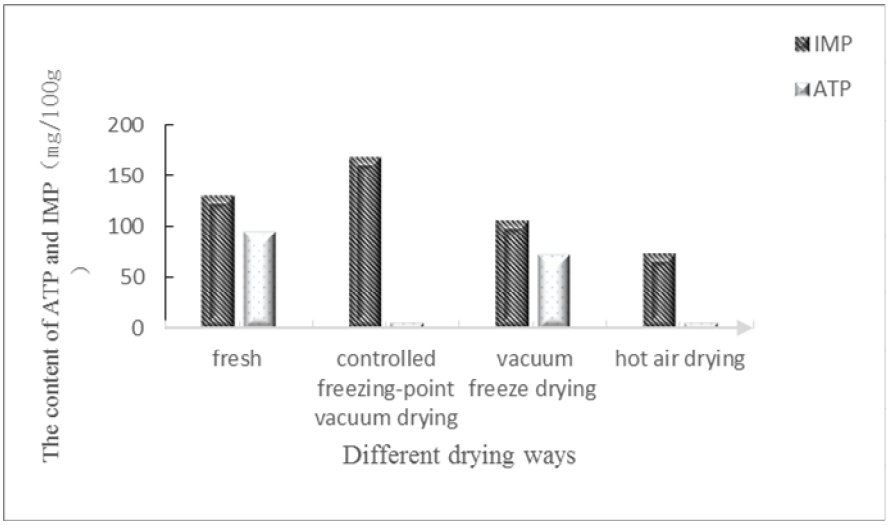

Figure 2-1The comparison of IMP and ATP content in *Pseudosciaena Crocea* fillet (mg/100g)

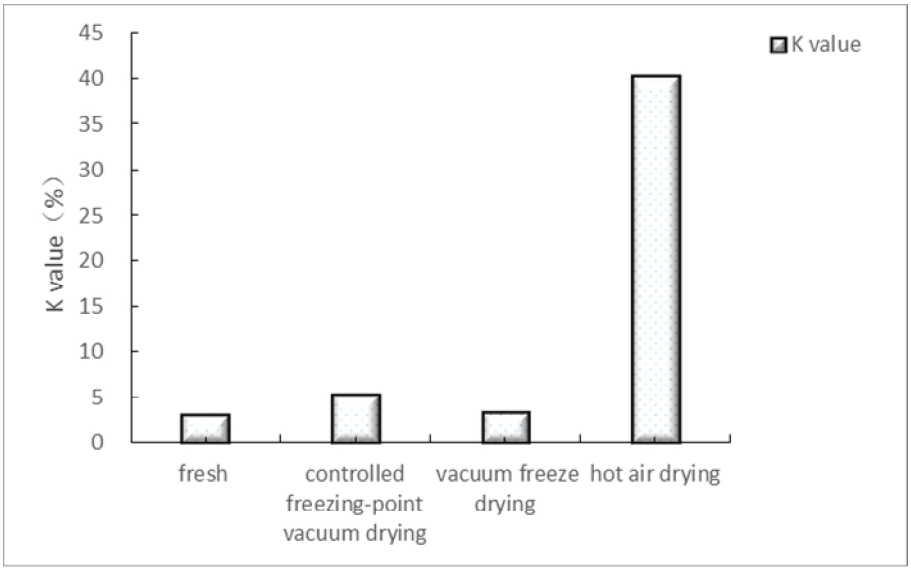

Figure 2-2 The comparison of K value in *Pseudosciaena Crocea* fillet

K-value trends under different drying methods was depicted in Figure 2-2 .Content of ATP and its associated product fluctuations caused changes of K value. The fresh fillet value was 3.06% , and K value of hot air drying was significantly higher than those of controlled freezing-point

vacuum drying and vacuum freeze drying, reaching 40.24%,while the latter both were 5.34%, 3.39%, respectively, remaining the excellent grade (less than 10%); at a level of freshness. Although K value of controlled freezing-point vacuum drying had a significant difference with that of fresh, the trend was not evident. Hot air drying showed more significantly difference than other ways, this may be because high temperature quicken a variety of biochemical reactions.

Total bacteria and TVB-N

Total bacteria and TVB-N of Pseudosciaena crocea fillets dried by three different drying methods were shown in Table 2. According to the GB2733-2005 fresh, frozen animal food hygienic standards : physico-chemical indicators TVB-N for marine fish in fishery products should low 30mg/100g; according to dried fishery product sanitation standard from GB/10144-2005 on bacteria indicators didn't exceed 30000cfu/g. From table 2, fillets of three different drying methods were all less than fresh, further that of controlled freezing-point vacuum drying was the lowest, conforming to international health standards. That meant drying to remove moisture could kill or inhibit the growth and reproduction of microorganisms. Latter was the best way to inhibit bacteria and prolong shelf life.

Table 2 The comparison of TVB-N and total bacteria count in *Pseudosciaena Crocea* fillet

Drying methods	TVB-N (mg/100g)	Total bacteria count (cfu/g)
Fresh	6.8	5.8*10^5
Controlled freezing-point vacuum drying	4.3	2.2*10^4
Vacuum freeze drying	7.7	2.5*10^5
Hot air drying	7.2	1.3*10^5

Maybe processing environment could explain the trend above, the low temperature in vacuum freeze drying was beneficial to inhibit bacteria ,but when equipment temperature increased to 20˚C during parsing drying, which provide a suitable environment for bacteria growth; Hot-air drying was carried out in the oven, and the high temperature led to the growth and reproduction of microorganisms and worst freshness. So, controlled freezing-point vacuum drying had significant advantages in maintaining freshness of fish fillets, ensuring the highest health ,safety and prolonging storage period.

Conclusion

1 Effects on the freshness and flavor of Pseudosciaena crocea induced by different drying ways were compared. Results showed that when the final moisture content was set to 20%, hot air drying rate was the fastest after 8h, followed by ice temperature vacuum drying during 20h,while vacuum freeze was the slowest after 24h.

2 In the light of the impact on the freshness and taste, results showed that K value of both controlled freezing-point vacuum drying and vacuum freeze drying remained the excellent grade (less than 10%) ,while hot air drying reached the second level. Maybe high temperature accelerated ATP to degrade completely, producing many small molecules. But they were still available for

general consumption and processing. IMP content of both hot air and vacuum freeze dry were reduced. On the contrast, the IMP of controlled freezing-point vacuum drying increased by 38mg/100g instead.

3 From micro-organisms and TVB-N index, values of three drying ways were far below the fresh , conforming to the hygiene standards . Furthermore, controlled freezing-point vacuum drying showed the lowest, indicating the storage of fillet was prolonged. From the above analysis, the quality of fillet dealt by controlled freezing-point drying was the best.

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