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Determination of the storage possibility salmon of essential oil of *Amomum Aromaticum* Roxb

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Abstract

The study aimed to determine the ability of cardamom oil to preserve salmon. Cardamom essential oil is recovered from fresh cardamom by steam distillation. Essential oil is yellow, and transparent, hot spicy taste and characteristic aroma. Salmon is rich in components such as proteins, lipids, vitamins, minerals, etc., so it is a favorable environment for microorganisms to grow and develop. The study conducted experiments to preserve fresh salmon with cardamom essential oil with the content of 0.3%, 06%, and 0.9% at the temperature of 10 °C. The study has determined the biochemical, microbiological, and organoleptic criteria of fresh salmon in the formulas after 2 days, 4 days, and 6 days of storage. Finally, the cardamom oil content of 0.6% was selected to develop the preservation process. Salmon after preservation has a natural bright yellow color, good elasticity, and no viscosity; has a natural smell mixed with the characteristic aroma of cardamom essential oil; Salmon broth is clear, and has a characteristic sweet taste and characteristic aroma. The biochemical indicators: water, protein, lipid, vitamins, and minerals did not change significantly compared to the original; did not detect the presence of microorganisms strains *Coliforms, Escherichia coli, Clostridium perfringens, Staphylococcus aureus,* and *Salmonella* in preserved salmon.

Keywords: salmon; sensory parameters; biochemical parameters; preservation ability; essential oil of *Amomum aromaticum* Roxb.

Practical Application: Using cardamom essential oil in salmon preservation.

1 Introduction

Essential oil of *Amomum aromaticum* Roxb is extracted and recovered from *Amomum aromaticum* Roxb of Ha Giang province by steam distillation. This essential oil is yellow, transparent, hot spicy, and has an attractive characteristic aroma (Nguyen et al., 2020). The constituents in essential oils account for a high proportion such as citral, neral, 7-tetradecane, 2-isopropyl benzaldehyde, eucalyptol, α -terpineol, α -phellandrene, β -pinene, α -pinene and β -myrcene... (Loi, 2014). The studies of Cui et al. (2017), and Martin et al. (2000) show th 7-tetradecane, 2-isopropyl benzaldehydehe at essential oil of *Amomum aromaticum* Roxb has strong antibacterial effect against some strains of microorganisms causing food spoilage, typically *Escherichia coli, Staphylococcus aureus,* and *Salmonella.* Therefore, adding the essential oil of *Amomum aromaticum* Roxb to food, has the effect of creating aroma and preserving food. Salmon is a cold-water fish, commonly grown in areas with cold climates and cold-water sources. In Vietnam, salmon is often grown in Moc Chau and Van Ho districts in Son La, Sa Pa town in Lao Cai, and Tam Duong district in Lai Chau... Salmon is a valuable food, and nutrients, such as proteins, lipids, vitamins, and minerals... this is a very favorable environment for microorganisms to grow and develop. Normally, salmon is kept in the refrigerator, for about 1 to 2 days, a bad smell appeared, reducing the quality of the fish quickly. Currently, in the country as well as in other countries around the world, salmon is often preserved by freezing preservation method. There are very few published studies on the application of the essential oil of *Amomum aromaticum* Roxb to preserve salmon. Therefore, the objective of this study is to determine the ability of the essential oil of *Amomum aromaticum* Roxb to preserve salmon, thereby contributing to increasing the use value of essential oil of *Amomum aromaticum* Roxb and serving as a basis for the development of the process of preserving salmon with this essential oil is of great scientific and practical significance.

2 Materials and methods

2.1 Raw materials

Essential oil of *Amomum aromaticum* Roxb in Xin Man district, Ha Giang, is exploited and recovered by steam distillation with Clevenger light essential oil distillation equipment (d < 1) (2.505.410) of Witeg company, from Germany.

Fresh salmon was purchased at the cold water fish farm in Moc Chau town, Moc Chau district, Son La province. Live fish are stored in containers equipped with oxygen aeration systems and transported by car with a time of 3 hours to the laboratory for slaughter and storage.

2.2 Chemicals used

The chemicals used in the analysis: Potassium sulfate, boric acid, sodium hydroxide, methylene blue, ethanol, n-hexane, distilled water, and pectin....

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2.3 Experimental setup method

Based on the results of exploratory research, to determine the effect of cardamom essential oil on the preservation of salmon, the experiment was carried out according to 4 formulas: **CT-A:** 5 kg salmon; 0% essential oil per salmon weight (control, no essential oil was used); **CT-B**: 5 kg salmon; 0,3% essential oil per salmon weight; **CT-C**: 5 kg salmon; 0,6% essential oil per salmon weight; **CT-D**: 5 kg salmon; 0,9% essential oil per salmon weight. These recipes are all made at 7 °C.

Experiment: Salmon, after slaughtering and cutting into equal pieces, with dimensions: 6 cm in length, 4 cm in width, and 2 cm in thickness), using a syringe to inject the essential oil of *Amomum aromaticum* Roxb into the pieces, salmon and spray this oil on the surface of the fish pieces (with the content of essential oil of *Amomum aromaticum* Roxb used for injection is 60% and the content of essential oil of *Amomum aromaticum* Roxb used for spraying is 40%), and then sealed with plastic bags polyethylene packaging and put in the refrigerator, adjust the temperature to about 7 °C. Periodically to the 2, 4, and 6 days, analyze and evaluate the biochemical, microbiological and sensory indicators of the test salmon. Experiment with these formulas and find the right formula to build a preservation procedure.

2.4 Methods of determining biochemical indicators

Determination of the water content of salmon according to Vietnamese standard TCVN 12608 (Vietnamese National Standards, 2019), protein determined according to Vietnamese standard TCVN 8134:2009 (Vietnamese National Standards, 2009b), lipid content determined according to Vietnamese standard TCVN 8137:2009 (Vietnamese National Standards, 2009a). The content of vitamin B_1 is determined according to Vietnamese standard TCVN 5164 (Vietnamese National Standards, 2008), vitamin B_2 according to Vietnamese standard TCVN 8975 (Vietnamese National Standards, 2011), and vitamin B_{12} according to Vietnamese standard TCVN 9514 (Vietnamese National Standards, 2012). The content of minerals is determined according to the method specific to each element: P content is determined according to Vietnamese standards TCVN 7141:2002 (Vietnamese National Standards, 2002). The contents of K, Ca, Mg, Fe, and Zn were determined according to Vietnamese standards TCVN 1537: 2007 (Vietnamese National Standards, 2007a). The pH of salmon was determined using litmus paper.

2.5 Methods for the determination of microbiological indicators

Coliforms strains were determined according to Vietnamese standards TCVN 6848: 2007 (Vietnamese National Standards, 2007b), *Escherichia coli* according to Vietnamese standards TCVN 9976: 2013 (Vietnamese National Standards, 2013), *Clostridium perfringens* according to Vietnamese standards TCVN 4991: 2005 (Vietnamese National Standards, 2005b). *Staphylococcus aureus* according to Vietnamese standards TCVN 4830-1: 2005 (Vietnamese National Standards, 2005a) and *Salmonella* according to Vietnamese standards TCVN 4829: 2005 (Vietnamese National Standards, 2005c).

2.6 Methods of determining sensory criteria

The sensory criteria of salmon are determined according to Vietnam standard TCVN 3215: 1979. The state, color, smell, and taste of salmon are determined according to a 5-point scale consisting of 6 levels, the sensory panel includes 9 members. The total score of the highest sensory indicators is 20 points and the lowest is 0 points. Calculate the average score of the panel members for each sensory criterion, then multiply by the corresponding important coefficient of that criterion called the weighted score of each criterion, then calculate the total number of points with The weights of all sensory indicators that have a common score. With good grades (18.6-20 points), good grades (15.2-18.5), average grades (11.2-15.1), poor grades (7.2-11.1), poor grades very poor (4.0-7.2), and bad (0-3.9). The important coefficients agreed upon by the panel were: The external color of the salmon (1.1), the elasticity of the salmon (1.3), the smell of the salmon (0.7), and the clarity of the water. boiled salmon (0.9) (Vietnamese National Standards, 1979).

2.7 Data processing methods

Using data processing method, by excel software to systematize information and data for analysis and evaluation. The analyzed data were processed for SAS 9.0 statistical analysis. Statistical hypothesis analysis was performed by ANOVA and the mean values were compared by LSD at $p < 0.05$.

3 Results and discussion

3.1 Biochemical, microbiological and sensory parameters of salmon

Conduct analysis of some biochemical, microbiological, and sensory indicators of fresh salmon before being put into storage. This scientific basis is used to determine the quality change of fresh salmon during storage. The results are shown in Table 1.

Research results show that fresh salmon has a water content greater than 70%, protein content of 20% greater, and lipid content greater than 5%. The content of vitamins and minerals in fresh salmon is also high, especially the content of K, Ca, Fe, P, and Zn. Salmon has a natural bright yellow color, good elasticity, a firm fish structure, and fish has a natural aroma, fish broth is clear and sweet. The analysis results also did not detect the presence of *Coliforms, Escherichia coli, Clostridium perfringens, Staphylococcus aureus*, and *Salmonella* in fresh salmon meat.

3.2 Effect of essential oil of Amomum aromaticum Roxb on the change of biochemical parameters of salmon during storage

In the process of preserving food in general and salmon in particular, in addition to the organoleptic criteria, the biochemical indicators also change over time. The purpose of preservation measures is to limit this variation to a minimum. The results of determining the changes in the biochemical parameters of salmon during storage are shown in Table 2.

Research results in Table 2 show in salmon preserved in the formula CT-A, the composition of water, protein, lipid, vitamins,

Table 1. Some biochemical, microbiological and sensory parameters of 100 g salmon before being put into storage.

No.	Biochemical, microbiological and sensory indicators	Result	No.	Biochemical, microbiological and sensory indicators	Result
1	Water (g)	71.25 ± 0.92	14	Zn (mg)	0.42 ± 0.02
2	Protein (g)	22.16 ± 0.64	15	Cu (μg)	54 ± 0.93
3	Lipids (g)	5.31 ± 0.32	16	pH	< 7
4	Vitamin A (μg)	31.28 ± 0.85	17	*Coliforms (CFU/g)*	not detected
5	Vitamin B_1 (mg)	0.24 ± 0.02	18	*Escherichia coli (CFU/g)*	not detected
6	Vitamin B_2 (mg)	0.06 ± 0.01	19	*Clostridium perfringers (CFU/g)*	not detected
7	Vitamin B_{12} (μg)	4.08 ± 0.7	20	*Staphylococcus aureus (CFU/g)*	not detected
8	Vitamin E (mg)	0.67 ± 0.06	21	*Salmonella (CFU/g)*	not detected
9	K (mg)	416 ± 3.53	22	The color of fish meat	Natural fresh gold
10	Ca (mg)	13.42 ± 0.54	23	The elasticity of fish meat	Good elasticity
11	Fe (mg)	1.13 ± 0.02	24	Fish broth	Transparent, sweet taste
12	Mn (mg)	0.06 ± 0.01	25	The smell of fish meat	Natural fragrance
13	P (mg)	237 ± 12			

and minerals all decreased compared to the preserved salmon in the formulas using starch essential oil of *Amomum aromaticum* Roxb. By the end of the 4 days, all the salmon pieces preserved in the CT-A formula were rotten. Among the 3 recipes using the essential oil of *Amomum aromaticum* Roxb to preserve salmon, the formula CT-B had a greater reduction in water, protein, lipid, vitamin, and mineral content than the preserved salmon in the other formulations CT-C and CT-D. The reason for this phenomenon is that the content of essential oil of *Amomum aromaticum* Roxb used to preserve salmon in the formula CT-B is low, not enough to inhibit the change of the biochemical parameters of the fish. Comparing the two formulas CT-C and CT-D, the results show that the changes in water, protein, lipid, vitamin, and mineral compositions are not statistically significant. Based on the pH, it was shown that, after 6 days of storage with essential oil of *Amomum aromaticum* Roxb at 7 °C, the pH of salmon stored in formula CT-B was greater than 7. This phenomenon occurred due to protein of fish was modified to release NH_3, causing the pH to increase, while that of salmon preserved in the formulas CT-C and CT-D the pH was lower than 7. This proves high concentrations of essential oil of *Amomum aromaticum* Roxb 0.6-0.9% had the effect of limiting the effective change of biochemical parameters of salmon during storage. Compared with salmon before being put into storage in Table 1, the change of these biochemical indicators took place slowly. Therefore, based on the change of biochemical indicators, to save costs during storage, choosing 0.6% essential oil of *Amomum aromaticum* Roxb content to build a process to preserve salmon is appropriate.

3.3 Effect of essential oil of Amomum aromaticum Roxb on the change of microbial parameters of salmon during storage

Microorganisms are the cause of the spoilage of salmon during storage. Therefore, all preservation methods are aimed at inhibiting microbial activity to prolong the shelf life of salmon. The results of determining the effect of the essential oil of *Amomum aromaticum* Roxb on the change of microbial parameters of salmon during storage are presented in Table 3.

Based on Table 3, shows that salmon preserved in CT-A formula, on the 2 days of storage, was contaminated with microorganisms *Coliforms, Escherichia coli, Clostridium perfringens, Staphylococcus aureus,* and *Salmonella*. By the end of the 4 days of storage, all of the salmon pieces in the CT-A formula were completely rotten. For salmon preserved in formula CT-B, by the 4 days of storage, some microorganisms were infected and by the 6 days, the permissible limit was exceeded, typically *Escherichia coli strains, Salmonella,* and *Coliforms.* That shows that with the content of *essential oil of Amomum aromaticum* Roxb 0.3%, it is not enough to inhibit the growth of these microbial strains. At the same time, the research results showed salmon preserved in the formulas CT-C and CT-D did not detect the presence of microbial strains *Coliforms, Escherichia coli, Clostridium perfringens, Staphylococcus. Aureus*, and *Salmonella.* Thereby, it was concluded that the *essential oil of Amomum aromaticum* Roxb content from 0.6-0.9% had an effect in inhibiting the growth of microorganisms that adversely affect the quality of fish fresh anise. This result is also consistent with the research results of Cui et al. (2017), and Martin et al. (2000) on the ability to inhibit the activity of the *essential oil of Amomum aromaticum* Roxb. Therefore, based on the microbiological criteria and to reduce the cost during the preservation process, the content of essential oil of *Amomum aromaticum* Roxb of 0.6% was selected as the basis for building a process to preserve salmon with essential oil of *Amomum aromaticum* Roxb at 7 °C.

3.4 Effect of cardamom essential oil on the change of organoleptic parameters of salmon during storage

The sensory parameters of fresh salmon are important to consumers. Sensory criteria were evaluated first on the outside surface, the color of fish meat, the elasticity of fish meat, and the smell of fish meat and fish broth. Sensory criteria of fresh salmon during storage were determined according to Vietnamese standard TCVN 3215-79. The results of the changes in sensory criteria are described in Table 4.

Sensory evaluation results in Table 4 show that, by the 4th day of storage, salmon in the CT-A formula, the outer surface of the fish flesh is pale yellow mixed with a long gray color, the fish meat is soft and appears soft bad smell, turbid fish broth, bad smell and sour taste, the total sensory score of 10.72 and poor

Table 2. Effect of essential oil of *Amomum aromaticum* Roxb on the change of biochemical parameters of salmon during storage.

Biochemical criteria	Storage time (days)	Experimental formulas			
		CT-A (0% essential oil)	CT-B (0.3% essential oil)	CT-C (0.6% essential oil)	CT-D (0.9% essential oil)
Water (g)	2	70.17 ^{a} ± 0.82	71.04 ^{b} ± 0.75	71.13 ^{cd} ± 0.83	71.09 ^{cd} ± 0.74
	4	69.34 ^{a} ± 0.63	70.67 ^{b} ± 0.52	71.04 ^{c} ± 0.54	70.83 ^{d} ± 0.42
	6	-	68.32 ^{b} ± 0.43	69.86 ^{c} ± 0.42	69.14 ^{d} ± 0.46
Protein (g)	2	21.16 ^{a} ± 0.54	21.87 ^{b} ± 0.42	22.09 ^{cd} ± 0.37	22.05 ^{cd} ± 0.32
	4	19.93 ^{a} ± 0.25	21.08 ^{b} ± 0.24	21.87 ^{c} ± 0.32	21.54 ^{d} ± 0.25
	6	-	20.67 ^{b} ± 0.15	21.18 ^{c} ± 0.24	21.04 ^{d} ± 0.23
Lipids (g)	2	5.09 ^{a} ± 0.13	5.17 ^{b} ± 0.12	5.25 ^{c} ± 0.13	5.19 ^{d} ± 0.12
	4	4.75 ^{a} ± 0.21	4.94 ^{b} ± 0.14	5.03 ^{c} ± 0.15	4.98 ^{d} ± 0.27
	6	-	4.73 ^{b} ± 0.21	4.87 ^{c} ± 0.22	4.81 ^{d} ± 0.32
Vitamin A (µg)	2	30.63 ^{a} ± 0.56	30.87 ^{b} ± 0.43	31.09 ^{c} ± 0.43	31.04 ^{d} ± 0.45
	4	29.24 ^{a} ± 0.42	30.18 ^{b} ± 0.54	30.95 ^{c} ± 0.42	30.82 ^{d} ± 0.57
	6	-	29.06 ^{b} ± 0.23	30.12 ^{c} ± 0.13	30.05 ^{d} ± 0.28
Vitamin B_1 (mg)	2	0.19 ^{a} ± 0.02	0.21 ^{b} ± 0.01	0.23 ^{c} ± 0.01	0.22 ^{d} ± 0.01
	4	0.17 ^{a} ± 0.01	0.19 ^{b} ± 0.02	0.21 ^{c} ± 0.01	0.21 ^{d} ± 0.01
	6	-	0.17 ^{b} ± 0.01	0.19 ^{c} ± 0.01	0.18 ^{d} ± 0.01
Vitamin B_2 (mg)	2	0.04 ^{ab} ± 0.01	0.04 ^{ab} ± 0.01	0.05 ^{cd} ± 0.01	0.05 ^{cd} ± 0.01
	4	0.03 ^{ab} ± 0.01	0.03 ^{ab} ± 0.01	0.04 ^{cd} ± 0.01	0.04 ^{cd} ± 0.01
	6	-	0.02 ^{b} ± 0.01	0.03 ^{cd} ± 0.01	0.03 ^{cd} ± 0.01
Vitamin B_{12} (µg)	2	3.95 ^{a} ± 0.32	3.98 ^{b} ± 0.42	4.03 ^{c} ± 0.34	4.02 ^{d} ± 0.34
	4	3.46 ^{a} ± 0.26	3.78 ^{b} ± 0.34	3.97 ^{c} ± 0.32	3.95 ^{d} ± 0.31
	6	-	3.04 ^{b} ± 0.23	3.73 ^{c} ± 0.25	3.56 ^{d} ± 0.25
Vitamin E (mg)	2	0.59 ^{a} ± 0.02	0.63 ^{b} ± 0.01	0.65 ^{c} ± 0.01	0.64 ^{d} ± 0.01
	4	0.52 ^{a} ± 0.02	0.59 ^{b} ± 0.02	0.63 ^{c} ± 0.02	0.61 ^{d} ± 0.02
	6	-	0.54 ^{b} ± 0.01	0.59 ^{c} ± 0.01	0.57 ^{d} ± 0.01
K (mg)	2	398 ^{a} ± 13	406 ^{b} ± 13	413 ^{c} ± 12	409 ^{d} ± 13
	4	345 ^{a} ± 12	367 ^{b} ± 12	391 ^{c} ± 13	375 ^{d} ± 12
	6	-	348 ^{b} ± 13	376 ^{c} ± 12	354 ^{d} ± 12
Ca (mg)	2	12.91 ^{a} ± 1.52	13.09 ^{b} ± 1.54	13.27 ^{c} ± 1.63	13.16 ^{d} ± 1.53
	4	11.74 ^{a} ± 1.27	12.63 ^{b} ± 1.32	12.85 ^{c} ± 1.25	12.73 ^{d} ± 1.27
	6	-	11.17 ^{b} ± 1.27	11.93 ^{c} ± 1.32	11.38 ^{d} ± 1.34
Fe (mg)	2	1.08 ^{a} ± 0.32	1.09 ^{b} ± 0.32	1.12 ^{cd} ± 0.47	1.12 ^{cd} ± 0.47
	4	1.04 ^{a} ± 0.34	1.05 ^{b} ± 0.24	1.09 ^{cd} ± 0.23	1.08 ^{cd} ± 0.32
	6	-	1.02 ^{bd} ± 0.23	1.05 ^{c} ± 0.35	1.02 ^{bd} ± 0.25
Mn (mg)	2	0.04 ^{a} ± 0.01	0.05 ^{b} ± 0.01	0.06 ^{cd} ± 0.01	0.06 ^{cd} ± 0.01
	4	0.03 ^{a} ± 0.01	0.04 ^{b} ± 0.01	0.05 ^{cd} ± 0.01	0.05 ^{cd} ± 0.01
	6	-	0.03 ^{bd} ± 0.01	0.04 ^{c} ± 0.01	0.03 ^{bd} ± 0.01
P (mg)	2	219 ^{a} ± 12	226 ^{b} ± 12	232 ^{c} ± 13	231 ^{d} ± 12
	4	207 ^{a} ± 8	214 ^{b} ± 7	228 ^{c} ± 6	219 ^{d} ± 7
	6	-	205 ^{b} ± 5	214 ^{c} ± 6	208 ^{d} ± 5
Zn (mg)	2	0.37 ^{a} ± 0.15	0.39 ^{b} ± 0.12	0.41 ^{cd} ± 0.13	0.41 ^{cd} ± 0.13
	4	0.31 ^{a} ± 0.17	0.34 ^{b} ± 0.15	0.37 ^{cd} ± 0.12	0.36 ^{cd} ± 0.12
	6	-	0.28 ^{bd} ± 0.13	0.31 ^{c} ± 0.17	0.27 ^{bd} ± 0.14
Cu (µg)	2	47 ^{a} ± 4	49 ^{b} ± 3	52 ^{cd} ± 3	51 ^{cd} ± 4
	4	42 ^{a} ± 2	46b ^{d} ± 2	48 ^{c} ± 2	46 ^{d} ± 3
	6	-	41 ^{b} ± 1	45 ^{c} ± 2	43 ^{d} ± 2
pH	2	< 7	< 7	< 7	< 7
	4	> 7	7	< 7	< 7
	6	-	> 7	< 7	< 7

In the horizontal row, numbers with different exponents have a statistically significant difference (with $P < 0.05$).

rating, by the end of the 4 days of storage, all salmon pieces in this recipe were spoiled completely. Compared with the preserved salmon in the formulas, CT-B, CT-C, and CT-D, the salmon in the formula CT-A had the lowest total sensory scores. The formula CT-A did not use the essential oil of *Amomum aromaticum* Roxb for preservation, leading to the growth and development of microorganisms, making the organoleptic parameters of the meat change more strongly than that of salmon preserved in other formulas. In 3 formulas CT-B, CT-C, and CT-D, the results showed that salmon preserved in formula CT-B with the content of essential oil of *Amomum aromaticum* Roxb used was 0.3%, after 6 days of storage. Salmon stock has a light yellow

Table 3. Effect of essential oil of *Amomum aromaticum* Roxb on the change of microbial parameters of salmon during storage.

Microbiological indicators	Storage time (days)	Limit of infection	Experimental formulas			
			CT-A (0% essential oil)	CT-B (0.3% essential oil)	CT-C (0.6% essential oil)	CT-D (0.9% essential oil)
Coliforms (CFU/g)	2	50	10	not detected	not detected	not detected
	4	50	30	10	not detected	not detected
	6	50	-	50	not detected	not detected
Escherichia coli (CFU/g)	2	3	5	not detected	not detected	not detected
	4	3	10	5	not detected	not detected
	6	3	-	8	not detected	not detected
Clostridium perfringers (CFU/g)	2	10	3	not detected	not detected	not detected
	4	10	12	8	not detected	not detected
	6	10	-	10	not detected	not detected
Staphylococcus aureus (CFU/g)	2	10	8	not detected	not detected	not detected
	4	10	12	5	not detected	not detected
	6	10	-	8	not detected	not detected
Salmonella (CFU/g)	2	0	not detected	not detected	not detected	not detected
	4	0	6	2	not detected	not detected
	6	0	-	5	not detected	not detected

Table 4. Effect of essential oil of *Amomum aromaticum* Roxb on the change of organoleptic parameters of salmon during storage.

Sensory	Guarantee time administrator (day)	Sensory description	Experimental formulas			
			CT-A (0% essential oil)	CT-B (0.3% essential oil)	CT-C (0.6% essential oil)	CT-D (0.9% essential oil)
The color of fish meat	2	Score	3.21 ± 0.13	3.79 ± 0.14	4.54 ± 0.21	4.51 ± 0.23
		Sensory review	The flesh of the fish is light yellow	Fish flesh is yellow	Fish flesh has a characteristic bright yellow color	Fish flesh has a characteristic bright yellow color
	4	Score	3.15 ± 0.27	3.29 ± 0.16	4.26 ± 0.13	4.25 ± 0.24
		Sensory review	The flesh of the fish has a light yellow color mixed with a long gray color	The flesh of the fish is light yellow	Fish meat has a characteristic yellow color	Fish meat has a characteristic yellow color
	6	Score	-	3.15 ± 0.24	4.12 ± 0.25	4.13 ± 0.13
		Sensory review	Unknown	The flesh of the fish has a light yellow color mixed with a long gray color	Fish meat has a characteristic yellow color	Fish meat has a characteristic yellow color
The elasticity of fish meat	2	Score	3.34 ± 0.13	3.65 ± 0.13	4.15 ± 0.26	4.18 ± 0.12
		Sensory review	Normal elastic fish meat	Good elastic fish meat	Good elastic fish meat	Good elastic fish meat
	4	Score	2.51 ± 0.24	2.82 ± 0.16	4.08 ± 0.13	4.06 ± 0.24
		Sensory review	Poor fish meat	Normal elastic fish meat	Good elastic fish meat	Good elastic fish meat
	6	Score	-	2.34 ± 0.17	3.72 ± 0.21	3.76 ± 0.25
		Sensory review	Unknown	Poor fish meat	Normal elastic fish meat	Normal elastic fish meat

Table 4. Continued...

Sensory	Guarantee time administrator (day)	Sensory description	Experimental formulas			
			CT-A (0% essential oil)	CT-B (0.3% essential oil)	CT-C (0.6% essential oil)	CT-D (0.9% essential oil)
The smell of fish meat	2	Score	3.12 ± 0.27	3.61 ± 0.12	3.79 ± 0.13	3.67 ± 0.21
		Sensory review	Fish meat has a normal smell	Fish meat has a normal natural smell	Fish meat has a natural aroma mixed with the typical aroma of cardamom essential oil	Fish meat has a natural aroma mixed with the strong aroma of cardamom essential oil
	4	Score	2.27 ± 0.14	3.21 ± 0.13	3.54 ± 0.12	3.35 ± 0.23
		Sensory review	Fish meat has a bad smell	Fish meat has a normal smell	Fish meat has a natural smell mixed with the characteristic aroma of cardamom essential oil	Fish meat has a natural smell mixed with the strong aroma of cardamom essential oil
	6	Score	-	2.59 ± 0.25	3.32 ± 0.13	3.19 ± 0.24
		Sensory review	Unknown	Fish meat has a bad smell	The meat has a natural smell mixed with the characteristic aroma of cardamom essential oil	Fish meat has a natural smell mixed with the strong aroma of cardamom essential oil
Fish broth	2	Score	3.04 ± 0.13	3.97 ± 0.12	4.61 ± 0.13	4.56 ± 0.21
		Sensory review	Normal fish broth	Fish broth in	Clear fish broth has a characteristic sweet taste	The fish broth is clear, sweet, mixed with the slightly spicy taste of cardamom essential oil
	4	Score	2.79 ± 0.16	3.02 ± 0.25	4.47 ± 0.24	4.42 ± 0.23
		Sensory review	Fish broth is cloudy, has a bad smell, has a sour taste	Normal fish broth	Clear fish broth has a characteristic sweet taste	The fish broth is clear, sweet, mixed with the slightly spicy taste of cardamom essential oil
	6	Score	-	2.67 ± 0.13	4.38 ± 0.21	4.23 ± 0.14
		Sensory review	Unknown	Turbid fish broth	Clear fish broth has a characteristic sweet taste	The fish broth is clear, sweet, mixed with the slightly spicy taste of cardamom essential oil
Sensory results	2	Score	12.71 ± 0.23	15.02 ± 0.14	17.09 ± 0.23	16.92 ± 0.14
		Sensory review	Medium	Medium	Rather	Rather
	4	Score	10.72 ± 0.25	12.34 ± 0.27	16.35 ± 0.14	15.89 ± 0.21
		Sensory review	Least	Medium	Rather	Rather
	6	Score	-	10.75 ± 0.23	15.54 ± 0.12	15.31 ± 0.23
		Sensory review	Unknown	Least	Rather	Rather

color mixed with a long gray color, has poor elasticity, has a bad smell, fish broth is cloudy, has no sour taste, has a total sensory score of 10.75, and is classified as poor. That shows that the 0.3% essential oil of *Amomum aromaticum* Roxb content is not able to effectively inhibit the activity of microorganisms. Comparison between the two formulas preserved CT-C with the content of essential oil of *Amomum aromaticum* Roxb 0.6% and the formula CT-D preserved with the content of essential oil of *Amomum aromaticum* Roxb 0.9%. The results showed that the salmon preserved in the formula CT-C had a characteristic bright yellow color, good elasticity, and no viscosity, a natural smell mixed with the typical aroma of essential oil of *Amomum aromaticum* Roxb, fish broth is clear, has a characteristic sweet taste, has a characteristic aroma and has a large layer of fat concentrated on the surface of the boiled water. Meanwhile, salmon preserved in formula CT-D, has a characteristic bright yellow color, good elasticity, and is not viscous, fish has a natural smell mixed with the strong aroma of essential oil of *Amomum aromaticum* Roxb and water boiled fish, has a sweet taste, mixed with the slightly spicy taste of the essential oil of *Amomum aromaticum* Roxb. All members of the sensory panel said that the salmon preserved in the CT-D recipe, after being boiled, tasted the spicy flavor of the essential oil. It shows that with the concentration of 0.9% essential oil of *Amomum aromaticum* Roxb used for preservation, it will make the salmon taste spicy and increase the cost of preservation. Therefore, based on the sensory criteria, in order to reduce product costs and limit the phenomenon of spicy salmon, the content of essential oil of *Amomum aromaticum* Roxb of 0.6% was selected as the basis for building a salmon preservation process fresh.

4 Conclusion

Experiments were conducted to preserve salmon with the essential oil of *Amomum aromaticum* Roxb with concentrations of 0.3%, 06% and 0.9% at the temperature of 7 °C. At the same time, the indicators were analyzed and evaluated. Biodigestibility, microbiological and organoleptic parameters of salmon in these formulas after 2 days, 4 days, and 6 days of storage. The results selected the content of essential oil of *Amomum aromaticum* Roxb 0.6% corresponding to the formula CT-C to develop the preservation process. Because the salmon is fresh in CT-C formula, after 6 days of storage, the salmon has a natural bright yellow color, has good elasticity, and is not viscous, the salmon has a natural smell mixed with the typical aroma of fish, essential oil of *Amomum aromaticum* Roxb, salmon broth in a clear, sweet taste and characteristic aroma. The biochemical parameters, such Water, protein, lipid, vitamins, and minerals, did not change significantly compared to the original salmon. At the same time, at this time, the presence of microorganisms such as *Coliforms, Escherichia coli, Clostridium perfringens, Staphylococcus aureus*, and *Salmonella was not detected* in salmon during storage.

Conflict of interest

The author declares the research results in this article to be completely honest. The data has never been used or rotated from other research projects in any form.

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