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Original Paper

A New Method for Producing Amino Acids and Preserving Tryptophan by Using Seafood and Waste

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Abstract

There are many problems in hydrochloric acid hydrolysis, and other acids are preferred. The main problem of hydrolysis is to use acid theory and calculation formula. Only the theory can be found from the textbook: the hydrolysis constant K=αNδ, which is problematic and not available. Had to establish a new theory and formula: "double Chen hydrolysis formula".

Tryptophan can be preserved by hydrolysis with citric acid. It does not cause racemization of amino acids. You get L-amino acids, you don't get D-amino acids. It is neutralized with hydrated lime to form insoluble calcium citrate and filtered out without any impurities. It can also remove heavy metals such as arsenic, cadmium, mercury, lead and chromium. It does not pollute the environment, retains the advantages of hydrochloric acid hydrolysis and overcomes its disadvantages. Residual calcium citrate is a good calcium supplement for livestock and poultry—is environmentally friendly.

Keywords

amino acid, Hydrolysis, Citric acid, Calcium hydroxide, Triangular conical bottle, Reaction still

1. Introduction

Sea (fresh water) products and their leftovers are rich in 17 kinds of protein amino acids, which contain more amino acids such as glycine, alanine and glutamic acid, so the taste is particularly good. It also contains more non-protein amino acids-taurine, which is very important to the human body, is an essential substance for newborn brain development, and has the role of protecting myocardium, anti-arrhythmia, treatment of myocarditis, reducing blood pressure, blood lipids and blood sugar. In addition, it also contains essential elements and trace elements such as calcium, potassium, magnesium, zinc, iodine, selenium and phosphorus.

Our coastline stretches coastal areas are extremely rich in Marine resources! For example, Jiaodong area leaves about 2.5 tons of scallop skirt scraps for every 1 ton of wet scallop production. Scallop skirts abound throughout the country; A large number of shrimp heads after processing shrimp in various places; A large amount of mussel meat after freshwater pearl is produced in Jiang and Zhejiang regions. The sea red in some areas of Longhai and Jiaodong of Fujian Province, near the Wolfi Island of Zhejiang Province, is difficult to sell because of its large output. The cooking juice after processing scallops, Jiangyao, clams, sea red and oysters all over the coast is thrown away in large quantities, which can be fully utilized.

Laver contains up to 32.5% to 39% amino acids, which is very rare and is very good for the production of amino acids and flavorings. Worth developing vigorously!

Amino acids make proteins, without which there would be no life. Producing amino acids in large quantities and reducing their price is a necessary means for human health and longevity.

The production of amino acids requires a balance of eight essential amino acids for the human body, in appropriate proportion to each other, in line with the FAO and the World Health Organization (FAO/WHO) model. Its production methods include hydrochloric acid hydrolysis method, enzyme hydrolysis method, chemical synthesis method and microbial fermentation method. Hydrochloric acid hydrolysis method has a long history, high production efficiency, cheap and easy to obtain raw materials, simple equipment, and can produce almost all kinds of amino acids at the same time, without causing racemization of amino acids. You get L-amino acids, you don't get D-amino acids. But without it, all the tryptophan that humans cannot survive is destroyed. The residual acid can not be removed, the salt generated by neutralization is difficult to remove, the hydrolysis odor generated is difficult to eliminate, and the environment is polluted. Because these technical problems can not be solved for a long time, the great potential of hydrochloric acid hydrolysis can not be played out, has been on the edge of elimination, other production methods came into being, to be greatly developed, but they do not have the potential technical advantages of hydrochloric acid hydrolysis method!

The biggest advantage of enzymatic hydrolysis is that the conditions are mild, and there is no need for high temperature, high pressure and acid-resistant equipment; The disadvantage is that the reaction time is long, and the hydrolysis is not easy to complete, the enzyme is very fragile, easy to inactivate, and the enzyme is generally more expensive and the efficiency is poor. Buffers must be added to stabilize the PH to ensure enzymatic hydrolysis. The inorganic salts produced after enzymatic hydrolysis cannot be removed, seriously affecting the purity of the product! The peptides produced have adverse allergic reactions in some human bodies.

Tryptophan was obtained by alkaline hydrolysis. Some amino acids will racemize, from L-type amino acids to D-type amino acids that the human body can not absorb, and the loss of nutrients is large, and can not be used to produce food.

Traditional extraction method, chemical synthesis method and microbial fermentation method are difficult to achieve the purpose of industrial production because of the high cost and complex process of precursors. So we find other acids for hydrolysis, but the main problem of acid hydrolysis method is the theory and calculation of acid quantity. From the textbook catalytic theory: hydrolysis constant $K=\alpha N\delta$, α is the catalytic coefficient of acid, N is the molar concentration, δ and hydrolysis temperature T, time t in a certain range is positively correlated. The hydrolysis effect is proportional to N.

The theory is flawed. 1) N increases with the decrease of water added. Due to the co-ionic effect, it inhibits each other, affecting the ionization of hydrogen atoms, but reducing the hydrolysis effect. 2) This theory fails to reflect the relationship between the amount of hydrolyzed acid and the different types of proteins and the different nitrogen content of hydrolysates. So this formula is not available. We had to build up new theories and formulas.

2. Theoretical Analysis

2.1 Hydrolysis Was Derived by the Acid Quantity Formula

The hydrolysis capacity is only related to the H+ ion in the hydrolyzed acid molecule. For many (Y) elementary acids, an acid molecule with Y H atoms may ionize into H+ ions. Therefore, the hydrolysis effect is related to the equivalent number of hydrolyzed acid. The purpose of hydrolysis is to break the polypeptide chain of nitrogen molecules in the raw material into free amino acids. The more the number of nitrogen molecules in the raw material, the more the equivalent number of hydrolyzed acid is required. This is a proportional relationship, written as the equation:

Equivalent number of hydrolyzed acid=number of raw nitrogen molecules ×***CC***..... (1), the proportional coefficient ***CC*** is called "double Chen hydrolysis coefficient", referred to as "hydrolysis coefficient".

∵ Molecular number of hydrolyzed acid=weight of hydrolyzed acid/molecular weight of hydrolyzed acid;

Equivalent number of hydrolyzed acid=number of molecules of hydrolyzed acid ×Y=(weight of hydrolyzed acid ×Y)/Molecular weight of hydrolyzed acid..... (2);

Raw material nitrogen molecular number=raw material nitrogen content/molecular weight of nitrogen 14.0067..... (3).

Substitute (2) and (3) into (1):

(Weight of hydrolyzed acid × Y)/Molecular weight of hydrolyzed acid=(nitrogen content of raw material /14.0067) ×***CC***.

∴ hydrolytic acid weight=(molecular weight of hydrolytic acid / 14.0067) × nitrogen content of raw material ×***CC*** ÷Y

=(Molecular weight of hydrolyzed acid/14.0067) × raw protein content ×16%×***CC***÷Y..... (4)

Double Chen hydrolysis formula.

General meat, poultry, eggs, fish, shellfish protein nitrogen content is 16%.

*2.2 Find Suitable **CC** and Hydrolysis Acid*

2.2.1 Double Chen Hydrolysis Coefficient ***CC***

Strong acid catalytic coefficient is high, ***CC*** can be smaller. Hard protein consists of bone, tendon, horn, hair, silk and other substances with large protein content, ***CC*** can be larger. ***CC*** is negatively correlated with hydrolysis pressure, temperature T, time t and air temperature. This is presented as Table 1 ***CC*** values for reference!

2.2.2 Acid for Hydrolysis

2.2.2.1 Inorganic Acid

Iodate and bromate are dangerous or carcinogenic substances. Sulfuric acid is a binary strong acid, which is easy to injure and destroy things. Nitric acid is too aggressive. It explodes. Phosphoric acid has a burnt taste. Hydrochloric acid polluted the environment, destroyed tryptophan, and the salt neutralized by hydrolyzed residual acid was difficult to remove. They are not suitable for use!

2.2.2.2 Organic Acids

Because it is necessary to neutralize the residual acid with lime after hydrolysis, it is necessary to consider the saturated solubility of its calcifiers, which is too large to be easily removed, preferably below 0.1, and it is also necessary to consider the taste. Saturated solubility of the following organic acid calcifiers (g/100ml)

Calcium formate 16.725. Calcium acetate 34. Calcium propionate 28.3, low threshold, bad smell. Calcium tartar 0.38, too exciting. Calcium lactate 4.54. Calcium gluconate 4.012. Apple calcium 0.8. Calcium oxalate 0.00067, taste heavy not available. Calcium citrate 0.0825, the best hydrolysis with citric acid, the catalytic coefficient α is acceptable, does not pollute the environment, the residual acid after hydrolysis is neutralized by hydrated lime to form calcium citrate precipitation, filtration removal, does not contain impurities, and preserves the very important tryptophan for the human body. The equipment is simple, the raw materials are cheap and easy to obtain, and the advantages of hydrochloric acid hydrolysis are retained and its disadvantages are overcome.

The disadvantages of citric acid hydrolysis are low catalytic coefficient and large dosage, and reflux hydrolysis is only used for experimental purposes. The production must be hydrolyzed using a reactor.

Alkaline hydrolysis is used to obtain tryptophan only. Most amino acids are racemic and do not produce food.

Enzymatic hydrolysis is costly and inefficient. Neutralization produces inorganic salts that cannot be removed.

Residual calcium citrate is the best calcium supplement for livestock, which is conducive to environmental protection!

3. Experimental Equipment and Method

3.1 Hydrolysis Equipment and Conditions

1) Reflux hydrolysis of 5L triangular cone bottle. With a 5L triangular cone bottle, plus a rubber plug, plug in the condensation tube, and connect the tap water to cool the hydrolyzed steam, so as not to burn the hydrolysate dry. It was heated in a temperature controlled electric furnace of 1500w and hydrolyzed at one atmosphere (1kg pressure) and 100^0C for 12 hours. Take care to regulate the temperature to prevent excessive boiling and dry the hydrolysate liquid.

2) Reactor hydrolysis. Use electric heating or oil heating 304 stainless steel reactor, volume according to need. With an anchor mixer. Run the blender at regular intervals for 10 minutes. Be careful not to fill the reactor too full, 70% can be. Hydrolysis at 2kg pressure, 112-118^0C for 12 hours. Be careful not to heat too much to avoid a burnt taste.

3.2 Citric Acid Hydrolysis. The Raw Material Is Hydrolyzed by Adding Citric Acid and Appropriate Amount of Water

3.2.1 Calculation of Acid Quantity for Hydrolysis

Citric acid $C_6H_8O_7$ (192.125), ternary weak acid Y=3. The ionization constant $K_{\alpha1}=7.4\times10^{-4}$, $K_{\alpha2}=1.7\times10^{-5}$, $K_{\alpha3}=4.0\times10^{-7}$. The citric acid required is calculated from Formula (4):

$M_{\text{Hydrolytic acid}}$=(molecular weight of hydrolytic acid/14.0067) × raw protein content ×16%×***CC***÷Y

$M_{\text{Citric acid}}$=(192.125÷14.0067)×(weight of raw material×protein content of the raw material) ×16%×***CC***÷3

=Weight of raw material×protein content of raw material ×***CC***×0.7315=weight of raw material×nitrogen content of raw material ×6.25×***CC***×0.7315..... 5.

Add appropriate amount of water for hydrolysis. M stands for weight. Select ***CC*** refer to Table 1.

3.2.2 Neutralization of Food Grade Hydrated Lime

$M_{\text{calcium hydroxide}}=(222.284\div384.251)\times M_{\text{citric acid}}=0.5785\times M_{\text{citric acid}}$... [6]

In order to prevent residual calcium hydrogen citrate $CaH(C_6H_5O_7)$ and calcium hydrogen citrate $CaH_4(C_6H_5O_7)_2$ from precipitating into calcium citrate $Ca_3(C_6H_5O_7)_2$, and to completely remove heavy metals, so that the hydrolysate reaches PH12-13, more hydrated lime is added for this purpose. Since the saturated solubility of hydrated lime $Ca(0H)_2$ at 20^0C is 0.16(g/100g), PH12-13 is reached at this time. Excess lime can be filtered out, and the saturated solubility of lime in the solution of 0.16g/100g will not affect the subsequent treatment.

3.2.3 After 3 Hours of Precipitation, Filter

3.2.4 Post-Processing

Under the strong alkaline PH12-13, the hydrolysate is neither delicious nor can amino acids be measured, and it is necessary to adjust it to weak acidity with acid. If neutralized with citric acid, small amounts of calcium hydrogen citrate $CaH(C_6H_5O_7)$ and calcium hydrogen citrate $CaH_4(C_6H_5O_7)_2$ May be produced to precipitate. $CaCl_2$ solution was formed by neutralization with food-grade hydrochloric

acid. The original $Ca(0H)_2$ had a saturation solubility of 0.16(g/100g), and the resulting $CaCl_2$ had a solubility of 0.23g/100g, which would not precipitate (the saturation solubility of $CaCl_2$ at 20^0C was 74.5%). With food grade hydrochloric acid 0.157g/100g can be neutralized to PH7. It is best to add more hydrochloric acid to reach about PH5 and taste better.

$2HCl + Ca(OH)_2 \longrightarrow CaCl_2 + 2\ H_2O$

72.922 74.09468 110.99

$M_{CaCl2}=(110.99 \div 74.09468) \times M\ Ca(OH)_2=1.4979 \times 0.16g/100g=0.23g/100g$

$M_{HCl}=(72.922 \div 74.09468) \times M\ Ca(OH)_2=0.9842 \times 0.16g/100g=0.157g/100g$

3.2.5 Expected Production V (volume)

According to the definition of extraction rate γ=product nitrogen content÷raw material nitrogen content =[Product volume V(mL)×product specified amino nitrogen content (g/mL)]÷[raw material weight (g)×nitrogen content of the raw material %].

∴ Product volume V(mL)=[raw material weight (g)×nitrogen content of the raw material %×γ]÷Amino nitrogen content specified in the product (g/mL).

∵ Nitrogen content of raw materials %=raw material protein content %×16%;

Product volume V(mL)=raw material weight (g)×protein content of the raw material %×16%×γ÷Amino nitrogen of the product (g/mL)…(7)

Reactor hydrolysis γ=50%~70%, reflux hydrolysis temperature is greatly affected by temperature, especially in winter, γ=35%~50%.

3.3 The Hydrolysis Capacity of Citric Acid Is Weaker Than That of Hydrochloric Acid, and It Is More Suitable For Hydrolyzing Seafood with Protein Content Below 30%

4. Experimental Results and Analysis

Scallop skirt was boiled and concentrated into scallop liquid (Table 2), which contained 4.82% total amino acids. Calculate the citric acid to be added from (5), add appropriate amount of water for reflux hydrolysis for 12 hours, hydrated lime neutralization, long-term precipitation, filtration and post-treatment.

4.1 Experiment 1

Scallop solution 2,120ml, select ***CC***=5.1. Add 422g citric acid. After hydrolysis, hydrated lime neutralization, long-term precipitation, filtration and "post-treatment". Scallop hydrolyzed juice 1,300ml. As shown in Table 3, the total amino acid content is 2.81%. The extraction rate was γ=35.7%.

4.2 Experiment 2

Laver 180g, ***CC***=7. Add 300g citric acid. After hydrolysis, hydrated lime neutralization, long-term precipitation, filtration and "post-treatment". Seaweed seasoning liquid 1640ml. As shown in Table 5, the total amino acid content is 1.26%. Extraction rate: γ=35.3%.

The above two experimental testing companies could not detect tryptophan, so they had to change to Zhongke Company for testing, as shown in Table 6.

4.3 Experiment 3

Scallop solution 2100ml, ***CC***=6.75. Add citric acid 138.2g. After hydrolysis, hydrated lime neutralization, long-term precipitation, filtration and "post-treatment". 1,730ml of scallop juice. As shown in Table 7, the total amino acid content is 2.4% and tryptophan 0.09%. The extraction rate was γ=41%.

4.4 Experiment 4

Laver 83g (Table 4), select ***CC***=8. Add 142g citric acid. After hydrolysis, hydrated lime neutralization, long-term precipitation, filtration and "post-treatment". Get laver juice 260ml. As shown in Table 8, the total amino acid content is 5.1% and tryptophan is 0.15%. The extraction rate γ=49%.

4.5 Experiment 5

Pinctada martensii meat 750g, with citric acid 440g. After hydrolysis, hydrated lime neutralization, long-term precipitation, filtration and "post-treatment". The total amino acid content was 3.27%. The extraction rate γ=(1300×3.27%) ÷(750×14.3%)=39.6%.

4.6 Experiment 6

1000L stainless steel reactor is adopted. Scallop skirt 270Kg, contains 8.8% protein, select ***CC***=2, add citric acid 35kg. After hydrolysis, hydrated lime neutralization, long time precipitation, filtration and "post-treatment". I have 500 liters of scallop juice. Contains 0.4% amino nitrogen. Extraction rate: γ=500×0.4%÷(270×8.8%×0.16%)=52.6%. Acceptance, smooth delivery.

5. Conclusion

1) The "double Chen hydrolysis formula" for calculating the amount of acid used for hydrolysis is derived, and the concept of "double aging hydrolysis coefficient ***CC***" is introduced.

2) Citric acid hydrolysis retains the advantages of hydrochloric acid hydrolysis and overcomes its disadvantages. After hydrolysis, it is neutralized with hydrated lime to produce calcium citrate precipitation, which is filtered to remove hydrolyzed residual acids, bases, salts and all heavy metals: As,Cd, Hg, Pb, Cr, etc. Does not pollute the environment. The equipment is simple, high efficiency, raw materials are cheap and easy to obtain, can produce amino acid, seasoning, compound condiments and so on. Suitable for hydrolysis of aquatic products,

3) Seafood hydrolysis to taurine, very important to the human body.

4) The head of prawn has many whiskers and shells which are difficult to handle. Amino acids can be extracted by hydrolysis with citric acid and flavoring can be produced.

5) The hydrolysis of citric acid does not occur racemization to obtain L-amino acids, and does not produce D-amino acids.

6) The citric acid hydrolysis method removes all salts and impurities, preserving the most important tryptophan for the human body. Push enzymatic hydrolysis and alkaline hydrolysis off the technical stage, no need to use them!

7) Residue is a good calcium supplement for livestock and poultry, which is conducive to environmental protection

Attached test report

Table 1. Hydrolysis Reinforcement Coefficient *CC* Reference Value

Quipment	The raw materials / Hydrolytic acid	Fish and shellfish ***CC***
Reflux hydrolyzed	HCl	3—4
	Citric acid	5—6
Reaction kettle hydrolysis	HCl	1. 8—2. 8
	Citric acid	2.4--3.4

Table 2. Experimental Scallop Liquid

鉴科检测 Janko Testing Service

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报告编号： JATF20061749a 检测报告

检测项目	分析结果 山东莱州扇贝汁（2）	检测依据
镉(mg/kg)	4.4	GB 5009.15-2014
无机砷(mg/kg)	0.27	GB 5009.11-2014 第二篇第一法
铅(mg/kg)	未检出（<0.04）	GB 5009.12-2017 第一法
总汞(mg/kg)	未检出（<0.01）	GB 5009.17-2014 第一篇第一法
铬(mg/kg)	0.11	GB 5009.123-2014
盐分(%)	21.20	SC/T 3011-2001
天冬氨酸*(g/100g)	0.38	GB 5009.124-2016
苏氨酸*(g/100g)	0.17	GB 5009.124-2016
丝氨酸*(g/100g)	0.15	GB 5009.124-2016
谷氨酸*(g/100g)	0.57	GB 5009.124-2016
甘氨酸*(g/100g)	1.91	GB 5009.124-2016
丙氨酸*(g/100g)	0.24	GB 5009.124-2016
缬氨酸*(g/100g)	0.14	GB 5009.124-2016
蛋氨酸（甲硫氨酸）*(g/100g)	0.054	GB 5009.124-2016
异亮氨酸*(g/100g)	0.093	GB 5009.124-2016
亮氨酸*(g/100g)	0.19	GB 5009.124-2016
酪氨酸*(g/100g)	0.12	GB 5009.124-2016
苯丙氨酸*(g/100g)	0.12	GB 5009.124-2016
赖氨酸*(g/100g)	0.19	GB 5009.124-2016
组氨酸*(g/100g)	0.12	GB 5009.124-2016
精氨酸*(g/100g)	0.24	GB 5009.124-2016
脯氨酸*(g/100g)	0.13	GB 5009.124-2016
以上氨基酸的总量（16 项）*(g/100g)	4.82	GB 5009.124-2016

Add too much water to increase ***CC***.

Table 3. Experiment 1 Results of Hydrolyzed Scallop Juice

中检华日 CCIC-Fairreach

报告编号：FRK202007351 第2页 共3页

检测结果：

检 测 报 告

序号	检测项目	单位	检测结果	检测方法
1	镉（以Cd计）	mg/kg	<0.02	GB 5009.15-2014
2	总砷（以As计）	mg/kg	1.2	GB 5009.11-2014 （第一篇 第二法）
3	铅（以Pb计）	mg/kg	0.0600	GB 5009.12-2017 （第二法）
4	总汞（以Hg计）	mg/kg	<0.05	GB 5009.17-2014 （第一篇 第一法）
5	铬（以Cr计）	mg/kg	0.21	GB 5009.123-2014
6	铜（以Cu计）	mg/kg	<0.5	GB 5009.13-2017 （第二法）
7	氨基酸总量	g/100mL	2.81	GB 5009.124-2016*
8	亮氨酸	g/100mL	0.01	GB 5009.124-2016*
9	苯丙氨酸	g/100mL	0.01	GB 5009.124-2016*
10	异亮氨酸	g/100mL	0.01	GB 5009.124-2016*
11	蛋氨酸	g/100mL	<0.01	GB 5009.124-2016*
12	苏氨酸	g/100mL	<0.01	GB 5009.124-2016*
13	精氨酸	g/100mL	0.03	GB 5009.124-2016*
14	天门冬氨酸	g/100mL	0.04	GB 5009.124-2016*
15	缬氨酸	g/100mL	0.01	GB 5009.124-2016*
16	脯氨酸	g/100mL	<0.01	GB 5009.124-2016*

Table 4. Experimental Laver

中检华日 CCIC-Fairreach

报告编号：FRK202008765 第2页 共3页

检测结果：

检 测 报 告

序号	检测项目	单位	检测结果	检测方法
1	总砷（以As计）	mg/kg	20	GB 5009.11-2014 （第一篇 第二法）
2	总汞（以Hg计）	mg/kg	0.010	GB 5009.17-2014 （第一篇 第一法）
3	镉（以Cd计）	mg/kg	0.77	GB 5009.15-2014
4	铬（以Cr计）	mg/kg	0.93	GB 5009.123-2014
5	铜（以Cu计）	mg/kg	13.5	GB 5009.13-2017 （第二法）
6	氨基酸总量	g/100g	32.5	GB 5009.124-2016*
7	铅（以Pb计）（干重计）	mg/kg	0.508	GB 5009.12-2017 （第二法）
8	亮氨酸	g/100g	2.47	GB 5009.124-2016*
9	苯丙氨酸	g/100g	1.48	GB 5009.124-2016*
10	异亮氨酸	g/100g	1.36	GB 5009.124-2016*
11	蛋氨酸	g/100g	0.61	GB 5009.124-2016*
12	苏氨酸	g/100g	1.99	GB 5009.124-2016*
13	精氨酸	g/100g	2.09	GB 5009.124-2016*
14	天门冬氨酸	g/100g	3.18	GB 5009.124-2016*
15	缬氨酸	g/100g	2.22	GB 5009.124-2016*
16	脯氨酸	g/100g	1.58	GB 5009.124-2016*
17	酪氨酸	g/100g	1.10	GB 5009.124-2016*
18	丙氨酸	g/100g	4.24	GB 5009.124-2016*
19	组氨酸	g/100g	0.47	GB 5009.124-2016*
20	丝氨酸	g/100g	1.70	GB 5009.124-2016*

Table 5. Experiment2 Hydrolyzed Laver Juice

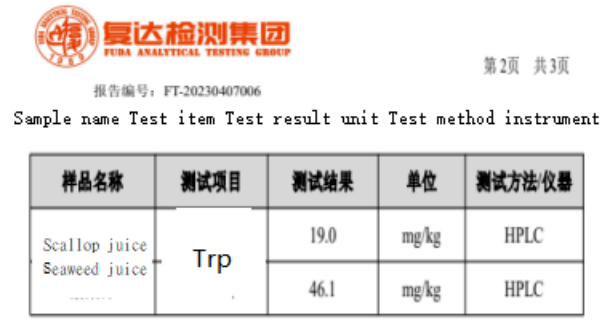
中检华日 CCIC-Fairreach

报告编号：FRK202008667 第2页 共3页

检测结果： 检 测 报 告

序号	检测项目	单位	检测结果	检测方法
1	铅（以Pb计）	mg/kg	<0.05	GB 5009.12-2017（第二法）
2	总砷（以As计）	mg/kg	0.38	GB 5009.11-2014（第一篇 第二法）
3	总汞（以Hg计）	mg/kg	<0.05	GB 5009.17-2014（第一篇 第一法）
4	镉（以Cd计）	mg/kg	<0.02	GB 5009.15-2014
5	铬（以Cr计）	mg/kg	<0.1	GB 5009.123-2014
6	铜（以Cu计）	mg/kg	<0.5	GB 5009.13-2017（第二法）
7	氨基酸总量	g/100mL	1.26	GB 5009.124-2016*
8	亮氨酸	g/100mL	0.02	GB 5009.124-2016*
9	苯丙氨酸	g/100mL	0.03	GB 5009.124-2016*
10	异亮氨酸	g/100mL	0.01	GB 5009.124-2016*
11	蛋氨酸	g/100mL	<0.01	GB 5009.124-2016*
12	苏氨酸	g/100mL	0.01	GB 5009.124-2016*
13	精氨酸	g/100mL	<0.01	GB 5009.124-2016*
14	天门冬氨酸	g/100mL	0.02	GB 5009.124-2016*
15	缬氨酸	g/100mL	0.01	GB 5009.124-2016*
16	脯氨酸	g/100mL	0.01	GB 5009.124-2016*

Table 6. Tryptophan in Hydrolyzed Scallop and Laver Juice



复达检测集团 FUDA ANALYTICAL TESTING GROUP

第2页 共3页

报告编号：FT-20230407006

Sample name Test item Test result unit Test method instrument

样品名称	测试项目	测试结果	单位	测试方法/仪器
Scallop juice	Trp	19.0	mg/kg	HPLC
Seaweed juice		46.1	mg/kg	HPLC

Table 7. Experiment 3 All Amino Acids in Scallop Liquid

北京中科智检检测技术院

报告编号：ZK-20230731004

表 1 扇贝汁测试结果

序号	测试项目	单位	测试结果	测试方法
1	氨基酸总量	g/100mL	2.40	GB 5009.124-2016
2	色氨酸	g/100mL	0.09	GB 5009.124-2016
3	亮氨酸	g/100mL	0.07	GB 5009.124-2016
4	苯丙氨酸	g/100mL	<0.01	GB 5009.124-2016
5	异亮氨酸	g/100mL	0.12	GB 5009.124-2016
6	蛋氨酸	g/100mL	<0.01	GB 5009.124-2016
7	苏氨酸	g/100mL	0.042	GB 5009.124-2016
8	甲硫氨酸	g/100mL	0.12	GB 5009.124-2016
9	精氨酸	g/100mL	<0.01	GB 5009.124-2016
10	组氨酸	g/100mL	0.08	GB 5009.124-2016
11	缬氨酸	g/100mL	0.13	GB 5009.124-2016
12	脯氨酸	g/100mL	0.14	GB 5009.124-2016
13	丝氨酸	g/100mL	0.12	GB 5009.124-2016
14	甘氨酸	g/100mL	<0.01	GB 5009.124-2016
15	谷氨酸	g/100mL	1.24	GB 5009.124-2016
16	赖氨酸	g/100mL	<0.01	GB 5009.124-2016
17	酪氨酸	g/100mL	0.24	GB 5009.124-2016
备注	1. 本实验室根据客户要求完成以上检测内容，检验结果仅适用于收到的样品。 2. 除全文复制外，未经实验室批准，不得部分复制本报告。 3. 标记"—"的测试项目表示不予判定或不具备判定条件。			

Table 8. Experiment 4 All Amino Acids in Laver

北京中科智检检测技术院

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表 2 紫菜汁测试结果

序号	测试项目	单位	测试结果	测试方法
1	氨基酸总量	g/100mL	5.1	GB 5009.124-2016
2	色氨酸	g/100mL	0.15	GB 5009.124-2016
3	亮氨酸	g/100mL	0.23	GB 5009.124-2016
4	苯丙氨酸	g/100mL	0.62	GB 5009.124-2016
5	异亮氨酸	g/100mL	0.22	GB 5009.124-2016
6	蛋氨酸	g/100mL	0.15	GB 5009.124-2016
7	苏氨酸	g/100mL	0.28	GB 5009.124-2016
8	缬氨酸	g/100mL	0.42	GB 5009.124-2016
9	甲硫氨酸	g/100mL	0.45	GB 5009.124-2016
10	天冬氨酸	g/100mL	0.82	GB 5009.124-2016
11	甘氨酸	g/100mL	0.35	GB 5009.124-2016
12	赖氨酸	g/100mL	0.38	GB 5009.124-2016
13	精氨酸	g/100mL	<0.01	GB 5009.124-2016
14	组氨酸	g/100mL	0.02	GB 5009.124-2016
15	脯氨酸	g/100mL	0.78	GB 5009.124-2016
16	丝氨酸	g/100mL	<0.01	GB 5009.124-2016
17	谷氨酸	g/100mL	0.23	GB 5009.124-2016
备注	1. 本实验室根据客户要求完成以上检测内容，检验结果仅适用于收到的样品。 2. 除全文复制外，未经实验室批准，不得部分复制本报告。 3. 标记"—"的测试项目表示不予判定或不具备判定条件。			

Table 9. Experiment 5 Test of Hydrolysate

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测试结果

表 1 马氏珍珠贝氨基酸液测试结果

序号	测试项目	单位	测试结果	测试方法
1	氨基酸总量	g/100mL	3.27	GB 5009.124-2016
2	甘氨酸	g/100mL	1.01	GB 5009.124-2016
3	丙氨酸	g/100mL	0.81	GB 5009.124-2016
4	缬氨酸	g/100mL	0.65	GB 5009.124-2016
5	亮氨酸	g/100mL	1.02	GB 5009.124-2016
6	异亮氨酸	g/100mL	0.61	GB 5009.124-2016
7	丝氨酸	g/100mL	0.49	GB 5009.124-2016
8	苏氨酸	g/100mL	0.60	GB 5009.124-2016
9	甲硫氨酸	g/100mL	0.35	GB 5009.124-2016
10	胱氨酸	g/100mL	0.04	GB 5009.124-2016
11	天门冬氨酸	g/100mL	1.32	GB 5009.124-2016
12	谷氨酸	g/100mL	2.10	GB 5009.124-2016
13	酪氨酸	g/100mL	0.49	GB 5009.124-2016
14	苯丙氨酸	g/100mL	0.49	GB 5009.124-2016
15	脯氨酸	g/100mL	0.48	GB 5009.124-2016
16	色氨酸	g/100mL	0.14	GB 5009.124-2016
17	精氨酸	g/100mL	1.03	GB 5009.124-2016
18	赖氨酸	g/100mL	0.88	GB 5009.124-2016
19	组氨酸	g/100mL	0.25	GB 5009.124-2016
20	牛磺酸	mg/100mL	1381	GB 5009.124-2016
21	有机砷	mg/kg	0.18	GB 5009.15-2014
22	镉	mg/kg	0.21	GB 5009.15-2014
23	汞	mg/kg	0.13	GB 5009.15-2014
24	铅	mg/kg	0.31	GB 5009.15-2014
25	铬	mg/kg	0.21	GB 5009.15-2014
备注	1. 本实验室根据客户要求完成以上检测内容，检验结果仅适用于收到的样品。 2. 除全文复制外，未经实验室批准，不得部分复制本报告。 3. 标记"—"的测试项目表示不予判定或不具备判定条件。			

Table 10. Experiment 6

The application of citric acid hydrolysis technology in the production of fresh scallop juice using a reactor in Yantai City, Shandong Province, China, won the "National Patent Technology Invention Gold Award".

Total amino acid 氨基酸总量。Gly 甘氨酸。Ala 丙氨酸。Val 缬氨酸。Leu 亮氨酸。Ile 异亮氨酸。Phe 苯丙氨酸。Trp 色氨酸。Tyr 酪氨酸。Asp 天冬氨酸。His 组氨酸。Asn 天冬酰胺。

Glu 谷氨酸。Lys 赖氨酸。Gln 谷氨酰胺 Met 甲硫氨酸。Arg 精氨酸。Ser 丝氨酸。Thr 苏氨酸。Cys 半胱氨酸。Pro 脯氨酸。

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