Research on the Effect of Glutamine Transaminase on the Gel Properties of Mutton

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Abstract. Glutamine transaminase is an enzyme that can catalyse the formation of valence bonds between the ε-amino group of lysine and the γ-hydroxylamide group of glutamic acid, resulting in the polymerization of chyme. In this paper, the sources, properties, mechanism of action and application of glutamine transaminase in lamb meat processing are described in combination with existing literatures. The bioavailability of its products is discussed. The results show that: glutamine transaminase, treatment the effects of temperature and reaction time on the cooking loss rate and characteristics of mutton gel are significant. The effects of glutamine transaminase, processing temperature and gellan gum on the properties of mutton gel are significant (P <0.05); temperature on glutamine transaminase There was significant interaction effect on the gel properties of mutton emulsion (P <0.05), but each factor had no significant interaction effect on the gel properties.

1. Introduction
Glutamine transaminase, also known as transglutaminase, is an enzyme that catalyzes the formation of a covalent bond between the ε-amino group of lysine and the γ-hydroxylamide group of glutamic acid, resulting in the polymerization of chyme. Since the minced meat after polymerization often exhibits better functional characteristics than before polymerization, the use of transglutaminase to improve the minced meat and improve the quality of meat products has increasingly become a hotspot in the food industry. China's total meat output ranks first in the world. Meat products account for only about 6% of total meat output, while foreign developed countries account for more than 45%, which shows that China has great potential for deep processing of meat products. How to develop new high-quality meat products has become an important subject for Chinese meat science and technology workers. In the process of making mutton minced gel properties, different treatments have an effect on the strength of mutton minced gel. It has been reported that glutamine aminotransferase treatment can greatly improve the properties of mutton gel [1]. Transglutaminase, as a new functional modifier of meat chime, is showing an increasingly important role in meat processing

2. Overview of minced meat products
Mutton is rich in nutrients and belongs to the Chinese herbal medicines. Eating mutton often can nourish blood, boost yang, nourish qi, and promote blood circulation. Lamb contains various essential amino acids, and fatty acid composition is mostly healthy unsaturated fatty acids, and there are many types of inorganic salts in mutton, which has good health care functions. The structure of mutton is
relatively thick, and the tenderness is poor. Processing with meat emulsion can largely overcome this shortcoming. Therefore, meat emulsion products will become a new direction for mutton processing [2].

The quality of minced meat products mainly depends on the functional characteristics of the muscle fibrous minced meat, which directly affects the gel characteristics of the minced meat products. Glutamine transaminase is an enzyme that catalyzes the transfer of phthaloyl groups between peptides or chyme. Myofibrillar is a good receptor for this enzyme. It can form a stronger covalent bond than disulfide under the catalysis of glutamine transaminase, which can cause cross-linking between the chyme molecules, thus improving the chyme coagulation [3]. Gum properties. The improvement of the meat gel's gel properties is mainly reflected in the gel properties and gel strength, and these properties are often measured in the product by the texture characteristics of the food that is, characteristics, friability, elasticity, resilience, etc. The texture facet analysis method can combine the sensory perception of texture with its mechanical and geometric properties. In recent years, it has been widely used in the study of the amino acid transglutaminase gel properties of glutamine [4].

![Figure 1. The process of Glutamine Transaminase in mutton gel](image)

The effect of glutamine transaminase on the properties of meat emulsion gels varies significantly depending on the type of meat. Scholars' research mainly includes the effects of glutamine transaminase on the properties of other meat emulsion gels [5]. To provide a reference for improving the quality of minced meat products, and to broaden the application of glutamine aminotransferase in the field of meat.

2.1. Basic preparation of minced meat products

2.1.1. Materials and reagents. The prepared mutton was purchased from the vegetable market; glutamine aminotransferase (enzyme activity 120U/g) was purchased from Market Fine Chemical Co., Ltd.; table salt was purchased from the vegetable market; potassium dihydrogen phosphate, borax, disodium hydrogen phosphate, citric acid Sodium was of analytical grade and was purchased from Chemical Reagent Factory of Market Fine Chemical Co., Ltd.

2.1.2. Instruments and equipment. BT-26S electronic balance ; PHS-3C+acidity meter; HH-6 digital thermostatic water bath; JJ-2 tissue mashing homogenizer: SXC26 meat grinder: TX-XTPlus physical property analyzer (adapter probe P50):
2.1.3. Preparation Process of Mutton Gel. Raw lamb→pretreatment→meat picking→ground meat→empty chopping→transaminase and auxiliary materials added with glutamine chopping→enzyme reaction→gelation→cooling→lamb minced gel sample [6].

The raw mutton is divided according to standard procedures. The mutton and mutton leg meat are cut to remove visible fascia, fat and connective tissue, cut into 1 cm³ pieces with a knife, and then made into a minced meat using a meat grinder (the meat hole of the meat grinder is 0.5 cm, 2 times), meat samples are packed in 250g portions and frozen at -25℃ until use.

Take 1 aliquot of the defrosted meat sample at 4℃ for 24h, put it in a tissue mashing homogenizer and cut it for 25s in the hollow, add 2% salt (based on the mass of the meat sample) and different amounts of glutamine. The transaminase solution is chopped for 130s (the temperature of the meat is measured every 30s and the temperature is controlled by adding ice water). The chopped process controls the total amount of liquid added to 50mL. After the chopping is complete, the mutton millet is transferred into a 120mL beaker. The enzyme is reacted for a certain period of time at a fixed temperature, a water bath at 90℃ for 15 minutes, and the mutton gel is placed in cold water to cool after heating, and then it is placed in a refrigerator (4℃) for 24 hours to prepare a mutton gel for later use.

Figure 2. Glutamine transaminase decomposition process

Figure 3. Study on the Conditions of Glutamine Transaminase
2.2. Optimization of glutamine aminotransferase conditions
The effect of glutamine aminotransferase addition on the properties of mutton gelatin: Take 4 parts of mutton after pretreatment. According to the method of preparing mutton gelatin, at natural pH, set the glutamine aminotransferase addition amount to 0.00, 0.65, 1.10, 1.55, 2.00, 2.45, 2.90 U/g, the temperature of the immobilized enzyme was 45°C, and the action time was 1 h. The samples were prepared for TPA measurement, and each treatment was measured 5 times in parallel. Effects of Glutamine Transaminase Temperature on the Properties of Mutton Gel: Take 4 parts of mutton after pretreatment. According to the preparation method of Mutton Gel, at natural pH, set the enzyme reaction temperature to 30°C, 35°C, 45°C, 45°C, 50°C, 55°C, 65°C, fixed enzyme action time 1h, the amount of glutamine transaminase added was 1.53 U/g, samples were prepared for TPA measurement, and each treatment was measured 5 times in parallel. Effects of Glutamine Transaminase Action Time on the Gel Properties of Mutton Minced Meat: Take 4 parts of mutton after pretreatment. At natural pH, the glutamine transaminase action time is set as: 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0h, the temperature of the immobilized enzyme was 45°C, and the amount of glutamine transaminase added was 1.53 U/g. The samples were prepared for TPA measurement, and each treatment was measured in parallel for 5 times. The effect of glutamine aminotransferase pH on the properties of mutton gelatin: 4 parts of mutton after pretreatment, the method of preparing mutton gelatin, and the pH was adjusted to 5.0, 6.0, 7.0, 8.0 with potassium dihydrogen phosphate-borax buffer respectively, 9.0, fixed enzyme action time 1.5h, glutamine transaminase addition amount 1.53U/g, enzyme action temperature 45°C, samples were prepared for TPA measurement, and each treatment was measured 5 times in parallel to prepare the primary product.

![Figure 4. Select 4 samples of mutton mill](image)

2.3. The key points of glutamine aminotransferase mutton chyme gel
Fresh grass and sheep with an individual weight of about 2kg should be used, and the freshness should meet the first-class freshness. Remove sheep scales, sheep head, viscera and endometrium; after washing with cold water (5-10°C), reduce the temperature of the sheep body to below 10°C. Pick the lamb's spine and lamb's meat, remove the thorns and lamb's bones. Note that this operation should be as fast as possible, and the temperature of the lamb should not exceed 10°C. Use a 0.5cm aperture grinder to grind meat, keeping the temperature of the lamb below 10°C. The stir-fried mutton is further homogenized into a miliform by a blender, and the temperature of the mutton should be kept below 10°C during homogenization to prevent the mutated meat from being denatured. After homogenization, the mutton millet was placed in the treatment tank, 4 to 5 times the amount of distilled water was added, and the treatment was repeated with slow stirring twice, and the treatment time was 15-25 minutes. The temperature of the treated water should be below 10°C. After the treatment is completed, the centrifuge is dehydrated at 3000 r/min for 4 minutes. Add 3% common salt to the mutton and stir at low temperature for 10 min. The chopped minced mutton was placed in a small beaker with a
diameter of 4 cm, and the height of the moulded minced mutton was 4 cm. After loading the mold, it was degassed in a vacuum box for 3 minutes at room temperature. The degassed minced meat is kept in a 45°C water bath for 65 minutes. Then it was kept in a 90°C water bath for 25 minutes to obtain mutton gel.

2.4. Determination of rupture strength and elasticity of mutton
Cut the top of the mutton gel with a thin blade, put it back into the beaker, and place it in a mass spectrometer to determine the gel's rupture properties. The measurement conditions are as follows. Modes and options: Determine compressive force. Probe speed before measurement: 2.00mm/s. Probe speed during measurement: 0.5mm/s. Probe speed after measurement: 2.00mm/s. Compression deformation: 70%. Measuring distance: 45.00mm. Trigger type: Automatic. Triggering force: 5.0g. Probe model: P/0.25s. The data acquisition rate is 450pps. Measure the force of the probe when the gel is broken by compression, that is, the strength of the fracture (g, which characterizes the gel) and the distance that the probe is pressed when the gel is broken (mm, the greater the distance of the depression, the more elastic the gel is). The strength of the gel is the product (g.mm) of the breaking strength of the gel and the distance the probe is pressed down.

2.5. Glutamine transaminase mutton minced
Take 6 equal portions of mutton from the homogenized mutton, and treat them with 0, 0.25%, 0.45%, 0.65%, 0.85% glutamine aminotransferase (10°C) according to the above method, and then treat with ice water once. Then, follow-up procedures are carried out according to the above process flow, and the prepared mutton emulsion gel is tested for the fracture properties of the gel according to the method of Treatment with sodium bicarbonate solution: Take 6 equal parts of mutton from the homogenized mutton, and use 0, 0.05%, 0.10%, 0.25%, 0.30% NaHCO3 solution (10°C) according to the above method, and then use ice water Treat it once, and then carry out the subsequent steps in accordance with the process flow. The prepared mutton emulsion gel is used to measure the fracture properties of the gel according to the method described above.

2.6. Glutamine Transaminase Pregel Treatment
Take 4 parts of minced mutton, add salt (3%), stir, load and degas, and incubate at 45°C in a water bath for 0, 10, 25, 45, 65min, then heat at 90°C in a water bath for 25min. The prepared minced mutton gel is in accordance with 1.3. The method of 3 measures the fracture properties of the gel.

Directly take 4 parts of mutton minced meat with salt (3%), stir, degas, and heat at 90°C for 25, 45, 65, 85, and 120 minutes. The prepared mutton minced gel is in accordance with the method of 1.3.3. The breaking properties of the gel were determined.
2.7. Results and analysis

2.7.1. Effect of Glutamine Transaminase on the Gel Properties of Mutton. It is an important procedure for processing mutton meat. The treatment can remove blood stains, fat, soluble meat emulsion and other components that affect the gel properties and color of mutton meat. The addition of 0.2% glutamine transaminase in the treated water increased the breaking strength of the gel from 211.6 g to 382.1 g in the blank, and the depression distance during the breaking increased from 6.05 mm to 8.95 mm in the blank. The concentration of glutamine transaminase increased from 0.2% to 0.6%, and the tendency of the mutton gel gel's rupture strength and elasticity to slow down, reaching the highest values of 454.5 g and 9.72 mm at 0.6%, respectively. However, the increase of the fracture strength and elasticity of the concrete decreases significantly. The 0.2% glutamine transaminase in the treatment solution increased the gel strength of mutton minced milk from 2639.26 g.mm to 3419.85 g.mm when blank, and reached a maximum value of 4103.72 g.mm at a concentration of 0.6%. Thereafter, the gel strength a sharp decline.

Glutamine transaminase affects the properties of mutton gel from two aspects. One is the activation of transglutaminase on the endogenous glutamine transaminase of mutton. The activated transaminase crosslinks polymerized mutton during the pre-gel treatment at 45°C. Meat chyme, enhances the strength and elasticity of the gel; the second is that the ion bridge of transaminase causes the chyme molecules to aggregate, thereby affecting the properties of the gel. When the concentration of glutamine transaminase is low (0.2%), the transaminase remaining after the mutton is treated is mainly used to activate the endogenous glutamine transaminase. The polymerization of the enzyme sharply increases the strength and elasticity of the gel; when the transaminase in the treatment solution At higher concentrations (0.2% to 0.6%), the bridging effect of ions and the polymerization of enzymes contribute to the properties of the gel; while when the transaminase concentration in the treatment solution is higher (0.8%), residual mutton remains More aminotransferases cause extensive aggregation of meat chyme before thermal gelation. This aggregation behavior reduces the strength and elasticity of the gel.
3. Conclusion
The above-mentioned adverse effects of glutamine transaminase on the cooking gel loss value of glutamine, which caused a significant increase in the gel cooking loss value of sheep muscle fibrillated meat (0.3 mol/L NaCl) (P <0.05). The experimental results were similar. The effect of glutamine aminotransferase on chicken meatballs was opposite. Glutamine transaminase can induce cross-linking (aggregation) of meat chyme, and this cross-linking is through salting muscle fiber meat chyme or being bound in the chyme gel matrix, resulting in an increase in the rate of cooking loss of meat or chyme. Gellan gum is an anionic polysaccharide, which may be restrained by enhancing the electrostatic effect, which is manifested by a reduction in the cooking loss rate of mutton gel. Gellan gum, which is a phenomenon that improves the water retention capacity of minced meat, is also found in low-fat mutton gel. The amount of glutamine transaminase added was significantly different in the proportions of the peak areas of different states of water in cooked mutton (P <0.05). After adding glutamine transaminase, indicating that it is within a certain range. Increasing the amount of transaminases added to glutamine is beneficial to the formation of gelatin structure of mutton. Increasing the amount of glutamine transaminase within a certain range can improve the characteristics of mutton. Compared with mutton minced meat without glutamine transaminase, transglutaminase supplemented with glutamine significantly improved mutton minced meat, cooking yield, characteristics, elasticity, cohesiveness and chew ability. With the maturity and improvement of microbial fermentation technology, glutamine transaminase has been widely used in recent years, especially in the meat processing industry. Glutamine transaminase catalysis not only imparts good texture to minced meat products, but also opens up some new food resources, which has a broad market prospect in the food industry.

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