Proceedings of the International Conference on Modern Medicine and Global Health (ICMMGH 2023)
DOI: 10.54254/2753-8818/6/20230239

Scientific facts on proteins when cooking

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Abstract. Protein is an essential part of food and makes a large contribution to the nutritional value of food. This paper evaluates protein by finding out the impact of different cooking methods on protein, and the influence of protein properties on the choice of cooking method. The results of this paper indicate that deep-frying maximizes the nutritional value of sturgeon. Cooking time and temperature have an impact on protein denaturation and nutritional value. Controlling heating time and temperature precisely can maximize retention of the color, flavor, and aroma of food. Using low-temperature vacuum cooking can reduce the loss of nutrients and moisture and also prevent secondary contamination. Different processes before cooking, such as basting, can not only increase the nutritional value but also enhance the flavor. The analysis can provide detailed information about the protein value and know what is the best way to cook sturgeon. It also provides a better understanding of the choice of cooking method and how to handle the food before cooking.

Keywords: protein, heating time, heating temperature, protein denaturation, cooking method.

1. Introduction

Protein is an integral part of daily diet, and adequate protein intake can meet the body's needs for nitrogen sources and amino acids and ensure healthy human growth and vital capacity aspects. However, it is a problem to not only cook the food well but also maximize the nutritional value of protein. This paper will discuss the impact of cooking methods on protein and nutrition, find out how heating time and temperature affect protein, and how protein properties affect the choice of cooking methods.

Adult sturgeon that has been raised in captivity are commonly used to produce fish sauce. After the egg harvest, the tissue of sturgeon gets old and stiff therefore lose the fresh tender sensation of fish meat, thus becomes the byproduct and restricts the sturgeon industry development. In order to improve the economic benefits of sturgeon meat, many researchers try to make food with sturgeon meat. For example, sturgeon flesh was cured and fabricated into sturgeon meat dry, produced as sturgeon flesh after flavoring, etc [1-2]. This paper discusses the impact on sturgeon protein nutritional value through different cooking method. Through the research, it is hoped that a theoretical basis can be provided for consumers and producers to choose a more reasonable way of cooking sturgeon meat.

After cooking the food comes the storage process. The heating time and temperature also have an impact on protein oxidation and thus have an impact on its nutritional value and storage duration. Low-temperature vacuum cooing was first used in cooking goose liver, which successfully reduced the

DOI: 10.54254/2753-8818/6/20230239

problem of water loss during cooking [3]. This new cooking method is warmly welcomed by people nowadays. At present, some studies domestically and abroad already reported applying low-temperature vacuum cooking in meat, vegetables, fruits, etc [4]. Researchers use chicken breast to study this problem and find out that both heating time and temperature have a great impact on the nutritional value of protein. Although the chicken breast is almost at an oxygen-free stage during the low temperature vacuum cooking, however, with the extension of heating time, the oxygen radicals present in food can still cause fat oxidation. Protein can not only accept the oxygen species and undergo oxidation during heating, but also indirectly undergo oxidation reactions with fatty oxidation products. This will cause changes in physicochemical properties of proteins and affect the nutritional value, flavor etc. There are not many researches on low temperature vacuum cooking on meat, only a few reports on lamb and beef [5-6]. Researches on low-temperature vacuum cooking chicken breast are limited, and chick is fast growing and highly used meat with a wide range of applications. So research on the chicken is of great meaning.

Also, protein properties also have an impact on choosing cooking methods. For example, the hydration of proteins has an impact on cooking meat. With more water bonded and firmly bonded, it is not easy to lose water during cooking so that the taste of food is more fresh and tender. And there is a research on this problem. Heating can cause the denaturation of protein. For example, if the temperature is too low, denaturing solidification is too slow or cannot be done, thus the cooking time is extended or the food cannot be cooked well. At the same time, a lot of oil is attached to the surface of food causing the greasy taste of food. Through the study of different properties of proteins, how protein affects cooking method is learned. We know how to use the properties of proteins for better cooking and ultimately there is a purposeful choice of ways to cook so that the food not only has a good flavor but also has the greatest nutritional value compared to using some random cooking methods.

2. How cooking methods affect protein

Protein plays a vital role in the daily diet. Humans need to consume enough protein to ensure nutrition. Protein on food nutrition labels represents a mixture of many different types of individual protein molecules. There are many factors that may have an effect on protein, such as cooking methods, heating temperatures and heating times. These not only affect the protein, but also change the nutrition value and digestibility, giving the food a particular taste and appearance. In addition, the properties of the protein can also have an impact on the choice of cooking method. Meat is rich in protein, and its intake is a good way to supplement it. In recent years, researchers from all over the world discuss the impact of cooking methods on meat. In terms of nutritional value, researchers compared the effect of an electric steam box and hot steamer on white cod meat and find out the basic nutritional substances of the electric steam box group is higher than the hot steamer group [7]. Although using the same cooking method, the type of meat shows different nutritional values. Chinese turtle leg meat and beef are all steamed and researchers find out that the protein digestibility and amino acid score of Chinese turtle leg meat are higher than that of beef [8]. The cooking method can also contribute to the flavor. Researchers find out that after steaming and frying the grass carp meat, fishy substances are reduced so that the meat tastes better [9]. Researchers also find out that heating can increase the volatile flavor substances of mackerel meat and decrease the smell of fishy [10]. However, there is not many researches on how cooking methods affect Acipenser sinensis Gray protein nutrition and flavor.

Protein efficiency ratio (PER) is often used as an evaluation index of the nutritional value of protein and the American Association of Analytical Chemists (AOAC) suggests that protein whose PER is higher than 2.0 can generally be considered to have high nutritional value. By testing the PER before and after the cooking process, the change to the protein's nutritional value can be learned. And the nutritional value can be calculated according to the human amino acid demand model proposed by the World Health Organization. Amino acid score(AAS), essential amino acid index (EAAI) can be calculated to measure the protein's nutritional value. AAS means the ratio of only one amino acid to the amino acid in the human amino acid demand model, however EAAI is the weighted ratio of

DOI: 10.54254/2753-8818/6/20230239

multiple amino acid, which means EAAI can reflect the nutritional value of amino acid better than AAS.

Experiments have shown that the water content of sturgeon meat after frying and steaming processes is significantly lower than that of raw sturgeon meat, which is due to protein denaturation. During cooking, the protein denaturation and the ability to bind water are reduced, and free water inside the cells escapes from the cells resulting in a loss of water content. The water content of fried sturgeon meat is higher than that of steamed sturgeon meat because during the frying process, a crust is formed on the surface of the meat to prevent water from escaping from the cells. The dry fat of cooked sturgeon meat is significantly lower than that of raw sturgeon meat due to the denaturation of the protein and the reduced ability to adhere after denaturation. The main reason for the increasing total amino acids in sturgeon meat after cooking is that protein gets degenerated by high temperature during cooking, and this results in the easier dissolution of amino acids in muscle protein. The glycine content in fried and steamed sturgeon is increased significantly probably due to chondroprotein degeneration. The back muscle of the sturgeon contains chondroprotein and is rich in glycine. After the heating process, the bone collagen is easy to dissolve during acidolysis.

According to the amino acid requirement model for children 2-5 years old, the AAS of fried sturgeon meat is significantly higher than steamed and raw sturgeon meat. And the EAAI of fried is also higher than that of steamed and raw sturgeon meat. The result is the same for the amino acid requirement model to adults. This illustrates that the nutritional value of fried sturgeon meat is higher than steamed and raw meat. Comparing the PER of different cooking methods, it is learned that frying can increase the nutritional value of sturgeon protein, and also make it easier for human digestion.

Water-soluble amino acids play an important role in food flavor and influence the special flavor of fish. For example, glycine and threonine have a pleasant sweet taste and give fish a sweet flavor. The sodium salt of glutamic acid provides freshness and increases freshness when used with guanosine and inosinic acid. Frying gives sturgeon meat a much higher content of odoriferous amino acids than steamed and raw meat, due to the high temperature during frying. The higher the degree of protein denaturation, the more amino acids are released from the protein, which results in high levels of malodorous amino acids.

From the study can conclude that frying is the best way to cook sturgeon meat compared to other cooking methods. After cooking the food, it is important to find a safe and hygienic way to preserve the food. There is a new cooking method called vacuum low temperature cooking, which means heating the vacuum-packed food at low temperature and cooking it for a long time. The temperature of heating is usually between 60-90℃, and the maxium eating time is 48h. This cooking method can lessen the loss of nutrition and water and prevent the secondary contamination. The precise control of time and temperature can maximum preserve the food's color, flavor and nutrient. There have already been reports about the applicant of this new cooking method [11].

3. Effect of heating time and temperature on protein

Studies have shown that heating time and temperature have a huge effect on protein and fat oxidation, however, researches on chicken haven't been done so much.

Research shows that cooking time and temperature have a significant effect on the content of CDHP in chicken breast cooked under a vacuum. When heating at 65℃ the CDHP content grows slowly. When heating at 75℃, the content of CDHP grows significantly. CDHP is formed at the initial stage of lipid oxidation and the process of unsaturated fatty acid side chain oxidation is often accompanied with the form of CDHP. So CDHP is an important indicator of evaluating the degree of early fat oxidation [12]. With the extension of heating time and the rise of heating temperature, the content of CDHP is growing.

Heating time and temperature have a significant effect on the content of protein carbonyl. When the heating temperature is the same, with the extension of heating time, there shows the trend that the content of carbonyl is continuously rising. Researches of Adeyemei shows that thermal processing can cause dramatic increase in the content of protein carbonyl [13]. The reason why the content of

DOI: 10.54254/2753-8818/6/20230239

carbonyl increases is that fatty peroxidanation generates free radicals and denatures the protein. Amino acids are very sensitive to the attack of superoxide anion radicals, especially amino acids with -NH or -NH2 on the side chain are even more sensitive to hydroxyl radicals. These sensitive functional groups are attacked by free radicals and are converted to carbonyl radicals. And this leads to the increase of carbonyl content [14]. At the initial stage of cooking, the content of carbonyl increases dramatically due to the extension of heating time and the sharp increase of heating temperature. However, when a certain time was reached, this change was no longer apparent, but the oxidation of the protein continued and the carbonyl content still increased.

Heating time and temperature also significantly affect the content of protein sulfhydryl in chicken breast. The content of sulfhydryl can reflect the degree of protein degeneration. With the extension of heating time and the rise of heating temperature, the content of sulfhydryl decreases. In the initial stage, the rate of the decline is the fastest. This is mainly because the hydrophobic genes buried in the interior of the protein surface become exposed, and the active hydrophobic group of the protein surface is easily oxidated and changed into disulfide bonds. Thus, the natural structure of protein is changed and protein degenerates and this causes the loss of nutrition. With the extension of heating time and the rise of the temperature, the oxidation of vacuum low-temperature chicken breast is getting worse.

4. Effects of protein properties on choosing cooking methods

Besides cooking methods have effects on protein and its nutritional value, the properties of protein also affect when choosing the cooking method. Understanding the properties of proteins and studying the changes of proteins in cooking process provides insight into the cooking principle. This helps people get the correct cooking method and help cook scientifically and reasonably.

Proteins have complex spatial structures and due to the folding and twisting of the polypeptide chain, the protein molecules have an approximately globular or elliptical globular shape. This kind of proteins have multi-hydrophilic groups on the surface and can strongly attract water molecules. As a result, the protein molecule is surrounded by multiple layers of water and forms a hydration film. The presence form of water and the amount affect the cooking and the senses of food directly. Food has more combined water is not losing water easily. And food has less combining water loses water easier and the taste of food is worse. The degree of hydration of proteins is also related to temperature. Moderate heating does not damage the ability of hydration. However high temperatures and a long time of heating damage the ability of hydration.

During cooking, when cooking some small raw materials is usually done by sizing. The sizing means mixing raw materials with salt, glutamate, starch and egg white. And this process forms a protective layer on the surface of meat and prevents water loss and heats the raw material indirectly Moderate heating is the rapid heating process in hot oil within 100℃. This process can maximally keep the moisture in the raw material and keep the food smooth and tender.

Despite the temperature and pH, the hydration capacity also relates to the strength of the ion. Low concentrations of salt whose electrolyte's positive and negative ions adsorb to the surface of the protein fraction thereby increasing the charge on the protein surface, which increases the degree of hydration. During the sizing process, salt is added to mix with raw materials. Protein is salt soluble and binds with more water, which makes the meat tender and soft [15].

The spatial structure of protein is easily affected by physical and chemical factors and these contribute to the degeneration of protein. Heating is the most common way to make protein degenerate. Protein denatures at the temperature above 50℃. The higher the temperature is, the faster the denaturation rate is, thus the time required for denaturation is shorter. If the temperature is too low, the denaturing solidification is too slow or the protein cannot denature thus the cooking time is extended or the food can’t be cooked well.

Proteolysis also has an impact on cooking. In order to tenderize the meat, tenderizer is always added during the cooking process. The principle of tenderizer is to hydrolysis meat under the action of enzymes. Tenderizer can break down collagen and elastin in meat with the action on proteases, and

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destroy the molecular structure of proteins, thus the meat can be tenderized. Also, tenderize has salt in it, combined with the salt added during sizing, with mixing, protein become salt soluble. This also enhance the water holding capacity of muscle tissue.

Sometimes baking soda is used to tenderize the meat. This is because proteins are denatured in the presence of a base. However, despite denaturation, the important nutrient called lysine is destroyed and generates toxic lysine endotoxin residues are produced. Therefore, the use of baking soda to tenderize meat is dangerous and is not recommended.

Denaturation of proteins is also related to heating time. During cooking, when initially heated the food first shrinks making the meat harder and tougher. This is because a short period of heating causes the gelatinous fibers to contract without destroying the structure of the protein. However, as the temperature rises the proteins gradually break down and the meat eventually becomes shorter. Using a pressure cooker accelerates the breakdown of the protein structure.

From the researches, the properties have an effect on choosing the cooking method. When selecting the proper cooking method, the damage to protein can be reduced, thus the loss of nutrition can be prevented and maximizing the nutrition of food.

5. Conclusion

From the research, it can be learned that frying is the best way to cook sturgeon. With the expansion of heating time and the rising of heating temperature, the more nutritional loss there will be in the chicken breast. Different treatment processes before cooking can reduce the nutrient loss from proteins, and sizing is a useful way to protect protein. Choosing the right material to tenderize is also important so that the food can be tenderized and not harm the health of body. Through the research, we get to know the reasons why there is a loss in nutrients in protein and learn to take measures to avoid this. Also, it is learned how to cook both with good flavor and with the greatest nutritional value at the same time. The study on the chicken breast is promising. Because the need for chicken in China is fast growing and is highly demanded. With the rapid rise of the fast meal industry and the promotion of ready-to-eat products, vacuum low-temperature heating chicken breast will be implemented widely.

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