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Effect of heat on protein: A review

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Abstract
All living things contain the highly complicated chemical known as protein. Proteins are extremely nutrient-dense and immediately contribute to the chemical reactions required for life. During cooking different heat treatment process are used to make suitable for human consumption but in those cases heat treatment effects on protein content. In this review the effect of heat on protein content is discussed.

Keywords: protein, heat treatments, structure, nutritional value, denaturation, browning of Proteins, loss of functionality, water-holding capacity

Introduction

Protein, a very complex substance found in all living organisms. Proteins have great nutritional value and are directly involved in the chemical processes necessary for life. The importance of protein was recognized by chemists at the beginning of the 1800s, including the Swedish chemist Jöns Jacob Berzelius, who in 1838 coined the term protein, derived from the Greek word prōteios, meaning "first. Proteins are species specific; that is, proteins of one species differ from proteins of another species (Braun & Gingra, 2012) [1]. They are also organ specific; For example, in, individual organisms, muscle proteins differ from brain and liver proteins (Lurie-Weinberger *et al*., 2005).

A protein molecule is very large compared to, sugar or salt molecules and consists of many amino acids linked together to form long chains, similar to beads on a string. About 20 different amino acids are naturally found in proteins. Proteins with similar functions have a similar composition and sequence of amino acids. Although it is still not possible to explain all the functions of a protein based on its amino acid sequence, the established relationships between structure and function can be attributed to the properties of the amino acids that make up the proteins (Combes *et al*., 2014).

At first level the polypeptide chain in the fundamental structure of proteins is made up of an arrangement of amino acids (Tewari *et al*., 2022) [14]. The protein structure of its basic structure is distinctive. Amino acids, which can be found wherever in the chain, make up the majority of the fundamental structure at this level. The basic structure of the protein contains peptide linkages. A dipeptide bond is created when two amino acids join together to produce a chain of proteins. Similar to this, a tripeptide is a group of three amino acids that are prepared to bind together. The stiff and planar nature of peptide bonds is one of its characteristics. It has a partial double bond character; it cannot charge; and it is polar (Vasanthi *et al*., 2007) [12].

In second-level architecture a polypeptide chain with a folding structure is part of the secondary structure of proteins. The H-bonds are what create this secondary structure. The alpha helix and beta pleated sheets play a major role in the formation of this secondary structure. Consider myoglobin. There are different kinds of secondary structure: Loops, Beta-plated sheet, Strand, and more (Schubring, 2008) [8].

Proteins have a tertiary structure that is a three-dimensional combination of their monomeric and multimeric forms. A polypeptide's three-dimensional structure is known as the protein's tertiary structure. This tertiary structure results from the polypeptide chain's lowest energy and most stable state. The folding of the protein's secondary structure produced the tertiary structure. Tertiary structure's purposes include: One of its special abilities is interacting with other molecules.

A collection of distinct polypeptide chains, proteins have a quaternary structure that takes the shape of a three-dimensional macromolecule. The tertiary structures that make up this quaternary structure were also combined in a unique way. The term "oligomeric proteins" also refers to quaternary structure. Example: Hemoglobin. Quaternary structure serves the following purposes: it aids in metabolism and chromosome replication.

Effect of heat on protein

Food goods must be cooked in order to produce a tasty and secure result. The majority of the components that make up the structure of the meat product are the meat proteins, which make up about 20% of the weight of a muscle. They go through significant structural changes during heating, and as a result, the quality of the finished meat product, which is mostly influenced by the flesh structure, also goes through significant alterations. This review will discuss the structural modifications that cooking for meat proteins causes in whole meat and minced meat products, as well as how these modifications affect the meat product's quality.

Zhou *et al*. (2015) [13] reported that the amount of soluble protein was much smaller after a 44-hour, 46 degree C heat treatment than it was in the control at room temperature, proving that the heat treatment greatly reduced the amount of soluble protein and prevented its synthesis. These outcomes are in line with those of Lurie *et al*. (2005) who discovered that heat treatment significantly reduced the ability of Granny Smith apples to synthesise proteins, by a factor of 50% to 80%. After harvest, the soluble protein level in all heat-treated fruit increased for the first three days before steadily declining until the end of storage, whereas it dropped in control fruit during chilled storage, which may be the result of defence mechanisms.

Zhou *et al*. (2015) [13] noted that the effectiveness of the heat treatment persisted throughout low temperature storage, which may be related to endogenous fruit reactions. The heat treatment may have increased protein synthesis, acting as a protective mechanism (Hu et al., 2005).

Tornberg (2005) [11] discussed the reactions of various meat proteins to heat. Although some of the sarcoplasmic proteins can coagulate up to 90 degree C, most of them combine between 40 and 60-degree C. Protein-protein association occurs for myofibrillar proteins in solution at 36–40 degree C, followed by gelation at 45–50 °C (conc. > 0.5% by weight). Unfolding begins at 30-32degree C. Collagen denaturation takes place between 53 and 63 degree C, which is followed by collagen fibre shrinkage.

Behaviour of meat proteins on heating

Tornberg (2005) reported that Denaturation is the term used to describe protein conformational changes brought on by heating. Differential scanning calorimetry has mostly been used to explore the denaturation temperature, which is the cooking temperature when conformational changes take place (DSC). Circular dichroism (CD) and optical rotary dispersion (ORD) can also be used to monitor the unfolding of proteins (the loss of helical structure) (CD). Measuring the surface hydrophobicity of the proteins using the fluorescent probe 8-anilino-1-naphtalene sulfonate is another method for monitoring the unfolding of the proteins (ANS). Protein-protein interactions, which lead to protein aggregation, are the next stage in the structural changes brought on by heating. Turbidity measurements and a reduction in protein solubility are the key tools used to study these processes. The capacity of the proteins to create gels and the types of gels they produce are often investigated using mechanical and microstructural measures.

Changes of properties of protein after heat treatment

1. Increased water-holding capacity

Proteins become more capable of storing water when heated, according to Cornell University. This indicates that the protein-containing food item has the capacity to absorb more moisture from the environment. It may not seem like a big deal, but keeping the right texture of yoghurt, for instance, depends on this function (Sun *et al*., 2022) [10].

2. Browning of Proteins

When food proteins, such as those in meats, are heated, a reaction known as the Maillard reaction occurs, according to the Accidental Scientist website (Maglara *et al*., 2003) [7]. Some of the food enzymes that were functioning before heating are destroyed during the Maillard reaction. When food is cooked, this results in a browning of the dish's colour, which is most frequently seen with beef and steak (Seibert *et al*., 2019) [9].

3. Protein Denaturation

According to Cornell University, the difficult process of protein denaturation generally entails cutting up the lengthy chains of amino acids that make up proteins into smaller fragments and less complicated chains. This happens when a protein is heated and when there is physical movement, like stirring. For instance, when you scramble an egg, you are effectively altering the structure of the egg by disrupting some of the chemical links that hold it together (Chen et al., 2022) [2].

4. Loss of Functionality

The functioning of proteins contained in various dairy products was examined in a study by Clemson University to see how it changed when they were cooked. According to the study, dairy proteins lost their solubility their capacity to dissolve in water when heated (Dai *et al*., 2014) [5]. They also lost a lot of their crucial roles in the production of food. Although heating protein helps with some manufacturing and baking processes, it hampers other processes (Christensen *et al*., 2000) [3].

Conclusion

In general, it could be two interconnected effects between protein aggregation and breakdown. Heat treatment dramatically decreased the amount of soluble protein in peach fruit while maintaining a higher level of HSP and a higher ratio of HSP to soluble protein. It was also concluded that heat treatment also effects on protein by increasing water holding capacity, by denaturation processes and by lowering functionality.

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