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A COMPARATIVE STUDY BETWEEN RED AND WHITE MEAT: A LITERATURE REVIEW

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ABSTRACT

Meat is a significant part of human diets, providing essential nutrients and playing a role in various culinary traditions. Therefore, this review article aims to focus on the physical-chemical characteristics and the contents of some mineral elements of red meat, compared to white meat, by reviewing the publications and previous studies conducted on this subject. Previous studies concentrated on comparing chicken meats to sheep, cows, and goats. Published studies showed differences in moisture, protein, ash, and other mineral elements such as potassium, calcium, magnesium, zinc, iron, manganese, and copper, and some toxic heavy elements, such as cadmium, lead, and chromium. Published articles showed that poultry breast meat had the highest protein content, averaging 21.99%. In contrast, the muscle of sheep and cow carcasses had the highest fat content, with an average value of 9.67%. The percentage of ash was 0.7% due to the low percentage of moisture. As for poultry meat, previous studies showed an average increase manganese, magnesium, and zinc levels in compare to sheep and cow meat, with high levels of potassium, iron, and zinc. In contrast, the published research showed a lack of copper in poultry and sheep meat. Previous studies have shown that there is a discrepancy in the content of the heavy metal elements lead, cadmium, and chromium between poultry, sheep meat, and cow meat, and its dependence on the highest and lowest level acceptable by FAO/WHO, which is 0.1 ppm for lead, 0.05 ppm for cadmium and 1 ppm for chromium in poultry. The researcher recommends implementing this study on the ground as a practical study to evaluate the physical and chemical characteristics of red and white meat and conducts actual comparisons between them, especially in the meat produced locally from Iraqi animals.

Keywords: cows, chicken, chemical composition, copper, Manganese, Potassium, Sheep.

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Introduction

Meat is considered one of the essential foodstuffs, and the demand for it has increased worldwide due to the increase in the population and food awareness. Meat is considered one of the primary sources of animal protein of high vital value; it also contains valuable animal fats and many essential and unsaturated fatty acids. Red meat (lean) has a low fat content and moderate cholesterol. Meat contains a group of vitamins, especially the vitamin B group, in its bioavailable form. Meat contains mineral elements, such as iron, zinc, and phosphorus, which are essential to the body's vital functions. Recently, poultry meat has spread, especially chicken meat, and its consumption has increased worldwide,

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especially after ensuring its meat is characterized by low-fat content, high nutritional value, and low manufacturing costs. The reports of the World Food and Agriculture Organization (FAO) (1) indicated in the statistics published in 2022 that global meat production increased in 2017, 2018, 2019, 2020, 2021, and 2022 (https://pbs.twimg.com/media/FgCZyZGX0AE9FTJ?format=jpg&name=larg. It amounted to 345.1 million metric tons for 2022 (Figure.1).

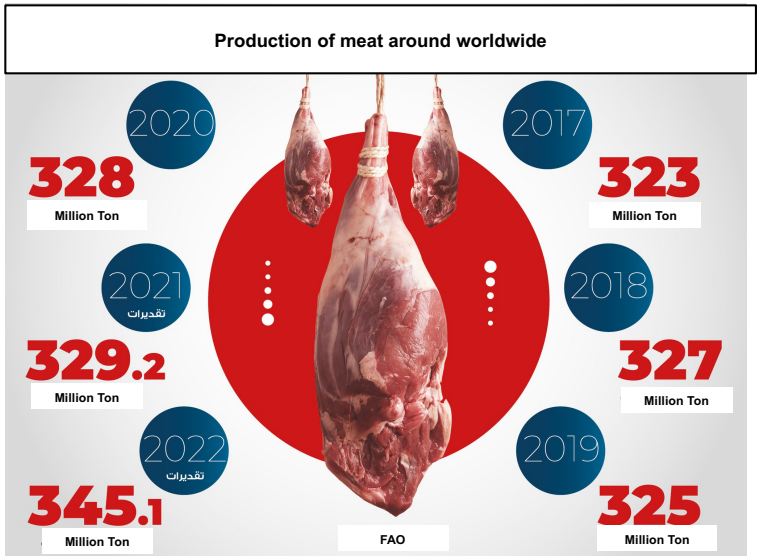

Figure.1: Shows the meat produced for 2017, 2018, 2019, 2020, 2021, and 2022.

According to the Iraqi Ministry of Agriculture reports meat production in Iraq is increasing due to the increasing demand for various types of meat. The statistics of meat production in Iraq in 2020 amounted to 103 thousand tons of white meat, "butchered poultry," 111.4 thousand tons of red meat, and 59.1 thousand tons of fish. They also mentioned, "There is an increasing demand for animal protein, especially with the population increase, as well as the rise in the standard of living and the rise in consumption rates," pointing out that the annual per capita need for white meat is 20-21 kilograms per year, while red meat is at an average of 12 kilograms per person per year (FAO, 2009; FAO, 2014; Directorate of Planning and International Cooperation, 2014). It has been noted that there is a lack of research and published studies that describe the chemical characteristics and basic components of red and white meat and the crucial differences between them. Consequently, this review article intends to explore the properties, composition, and nutritional values of red meat (sheep and cows) and white chicken meat and their differences via a review of the previously published research.

Methods

A comprehensive review has been done using specific Keywords on multiple platforms or databases, including Google Scholar, PubMed, and specialized academic databases like IEEE Xplore, ScienceDirect, or Web of Science. Potentially relevant articles, including their metadata (title, authors, and publication date) and abstracts that focused on the current were collected and used in writing the current review article.

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Red and white meats and their chemical composition

Red and white meats differ in terms of their chemical composition (IARC, 2018), which contributes to their distinct flavors, colors, textures, and nutritional profiles. Previous studies described the chemical composition of red and white meats. Red meat gets its name from its higher myoglobin content, which gives it a reddish color. The myoglobin is a protein that stores oxygen in muscle tissues. It's responsible for the red color and contributes to the meat's flavor and juiciness. The red meat is considered as a significant source of heme iron, a form of iron that is easily absorbed by the body. This contributes to the meat's reddish hue and its importance as an iron-rich food source. Depending on the cut, red meat can have varying levels of intramuscular fat (marbling). This fat contributes to the meat's tenderness, juiciness, and flavor. Additionally, red meat can contain higher levels of saturated fat, particularly in fattier cuts. Excessive consumption of saturated fat may be linked to health concerns like heart disease. The red meat is rich in high-quality protein, B vitamins (B12, B6, niacin), zinc, selenium, and phosphorus. White meat, found in poultry like chicken and turkey, is lighter in color due to lower myoglobin content. The white meat contains less myoglobin than red meat, contributing to its paler appearance. While white meat has less heme iron than red meat, it still provides some iron. Moreover, white meat generally has lower levels of intramuscular fat compared to red meat. Skinless poultry cuts are particularly lean. The skinless poultry, is often considered a leaner protein source with lower saturated fat content. It is also a good source of high-quality protein, B vitamins (B6, niacin), and minerals like phosphorus and selenium. Meanwhile, both red and white meats provide essential amino acids required for building and repairing tissues and rich in complete proteins, containing all nine essential amino acids. Nevertheless, a varying levels of fat-soluble vitamins, including vitamin A and vitamin D are reported (Cobos & Díaz, 2015). Furthermore, the impacts of the chemical composition of red and white meats on their culinary applications, cooking methods, and health considerations were also reported. The choosing lean cuts, moderating portion sizes, and balancing meat consumption with a variety of other foods are recommended for health-conscious diets.

The Nutritive Value of Red and White Meat

Red and white meats offer distinct nutritional compositions, each contributing essential nutrients to human diets. The rich protein content, along with vitamins and minerals like iron, B vitamins, zinc, and selenium, makes both types of meat indispensable for bodily functions. By understanding their nutritive values and making informed dietary choices, people can bind the benefits of red and white meats while maintaining a balanced and health-conscious lifestyle (Figure. 2).

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Figure.2: Shows both fresh red and white meats

Meat, a staple in diets worldwide, comes in various forms and types, each offering a distinct nutritional composition. Among these, red and white meats stand out as primary sources of protein, vitamins, and minerals that contribute significantly to our dietary needs. Red meat, derived from mammals like cattle, sheep, and pigs, is characterized by its deep, reddish hue, owing to the presence of myoglobin, a protein that stores oxygen in muscle tissues. This coloration also signifies its rich nutritional content. Red meat is renowned for its high-quality protein content, making it an essential source of all nine essential amino acids crucial for tissue repair, growth, and various metabolic functions. Iron is a standout nutrient in red meat. Its heme iron form, easily absorbed by the body, helps prevent iron-deficiency anemia and supports oxygen transport. Additionally, red meat is a treasure trove of B vitamins, including B12, which plays a vital role in nerve function and DNA synthesis, and B6 and niacin, essential for energy metabolism. The presence of zinc and selenium enhances the immune system and provides antioxidant protection. The mineral phosphorus aids in bone health and energy production. The richness of red meat also extends to its fat content. While marbling contributes to its flavor and tenderness, the fat content should be moderated for overall health. Selecting lean cuts and consuming red meat in moderation can harness its nutritive benefits without excessive calorie intake. Whereas, white meat, exemplified by poultry like chicken and turkey, offers a lighter color due to lower myoglobin content. Despite its pale appearance, white meat is a powerhouse of protein, akin to red meat. This protein content supports muscle health, tissue repair, and immune function. White meat is particularly favored for its lower fat content, making it an attractive option for those conscious of saturated fat intake. While white meat provides less heme iron compared to red meat, it still contributes to dietary iron intake. The B vitamins found in white meat, such as B6 and niacin, are crucial for energy metabolism and maintaining healthy skin. Selenium, an antioxidant mineral, supports cellular function and immune response. As with red meat, the mineral phosphorus enhances bone health. The nutritive value of both red and white meats positions them as valuable components of a balanced diet. However, responsible consumption is essential (Lim *et al.,* 2021). Excessive consumption of red and processed meats has been linked to certain health concerns, such as heart disease and cancer. Moderation and mindfulness in portion sizes are crucial to harness their benefits without compromising overall health.

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1. Meat protein

The structure of meat proteins is a complex hierarchy of primary, secondary, tertiary, and quaternary levels (Bohrer, 2017). These structures dictate the protein's function, biological activity, and interactions with other molecules. Understanding the protein structure of meat is essential for grasping its role in both the culinary and nutritional aspects of food. Proteins are composed of amino acids, which are linked together in specific sequences to form polypeptide chains. These chains fold and interact to create the unique three-dimensional structures of different meat proteins (Tornberg, 2005). The primary structure of meat proteins refers to the linear sequence of amino acids in the polypeptide chain. The amino acids are the building blocks of proteins, and their sequence determines the protein's specific properties and functions. The sequence of amino acids is encoded in the genetic code and is unique to each protein. The primary chain of amino acids can fold into local structures known as secondary structures. The two most common secondary structures are the alpha helix and beta sheets. The alpha helix is a spiral structure formed by hydrogen bonds between the amino acids along the chain. Beta sheets consist of segments of the polypeptide chain lying alongside each other and forming hydrogen bonds. The tertiary structure is the overall three-dimensional folding of the polypeptide chain. This folding is driven by various interactions, including hydrogen bonds, disulfide bonds, hydrophobic interactions, and electrostatic interactions. The tertiary structure gives the protein its final functional shape and determines its specific biological activity. Some meat proteins consist of multiple polypeptide chains, known as subunits, that come together to form a functional protein complex. The quaternary structure is the arrangement and interaction of these subunits. Myosin and actin (Figure. 3) the important components of the muscle fibers are the examples of protein complexes in meat include, which are of muscle (Murray, 2003).

The three-dimensional structure of meat proteins is critical for their functionality. Cooking and heat exposure can cause denaturation, which is the disruption of protein's secondary, tertiary, or quaternary structure. The denaturation can lead to changes in texture, color, and taste in cooked meat.

There are several functions of meat proteins including structural support, enzymatic activity, transportation of molecules, and immune defense. In muscle tissues, proteins like myosin and actin are responsible for muscle contraction and movement.

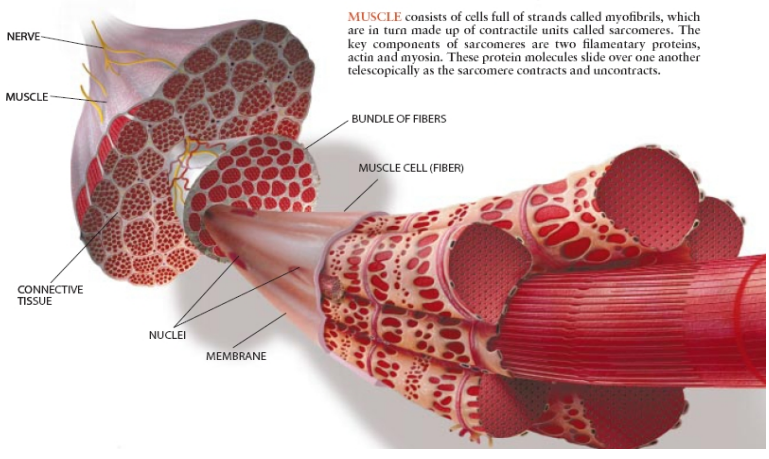

Figure.3: Shows the structure of meat protein

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2. Meat Fat

The fat content in red and white meat varies based on factors such as the type of meat, the cut, and the animal's diet and genetics (Bergeron *et al.,* 2019) Red meat generally has a higher fat content compared to white meat. Some cuts of red meat, such as certain cuts of beef, lamb, and pork, contain intramuscular fat, also known as marbling. Marbling refers to the distribution of fat within the muscle tissue and contributes to the meat's tenderness, flavor, and juiciness. Red meat can be higher in saturated fat, particularly cuts with visible fat or marbling. Excessive consumption of saturated fat may have health implications, so it's important to choose lean cuts and practice moderation. Red meat can contain both omega-3 and omega-6 fatty acids (Wood *et al*.,2008), but the ratio depends on factors like the animal's diet. Grass-fed or pasture-raised animals may have higher omega-3 content compared to conventionally raised animals. The white meat, such as poultry (chicken and turkey), typically has lower fat content compared to many cuts of red meat. Most white meat cuts are lean, meaning they have minimal visible fat and marbling. The white meat is generally lower in saturated fat compared to many cuts of red meat. However, white meat, particularly poultry, can also provide omega-3 and omega-6 fatty acids, though the content might be lower compared to fatty fish or certain plant sources.

3. Meat minerals

The mineral content of red and white meats can vary based on factors such as the type of meat, the animal's diet, and the cooking method. While both red and white meats provide essential minerals, there might be some differences in their content due to the characteristics of the meat. Both red and white meats are good sources of heme iron, which is highly bioavailable and easily absorbed by the body. Iron is essential for oxygen transport and energy metabolism. Both types of meat provide zinc, which is important for immune function, wound healing, and various enzymatic processes. Both red and white meats contain phosphorus, a mineral necessary for bone health, energy production, and maintaining pH balance. Both types of meat contain selenium, an antioxidant mineral that supports immune function and thyroid health. Meats, whether red or white, are generally rich in B vitamins such as niacin (B3), riboflavin (B2), and vitamin B12. However, additional minerals were found in red or white meat. Red meats, particularly organ meats, are relatively higher in copper, which is important for iron metabolism, collagen formation, and antioxidant defense. While not as abundant as in some plant-based sources, red meats still contribute to potassium intake, which is crucial for fluid balance and nerve function. However, some bone-in white meat cuts may contain small amounts of calcium from the bones. While, dairy products and plant-based sources are primary contributors of calcium (Juárez *et al.,* 2021). Whereas not a primary source of magnesium, white meats can provide some contribution to overall magnesium intake.

4. Meat Vitamins

Red and white meats are good sources of various vitamins, which play essential roles in maintaining overall health and well-being. The vitamin content in meat can vary based on factors such as the type of meat, the animal's diet, and cooking methods. Both red and white meats are rich in B vitamins, which are important for energy metabolism,

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nervous system function, and overall cellular health. B vitamins commonly found in meats include:

- Vitamin B12: Essential for red blood cell formation, nerve function, and DNA synthesis.
- Niacin (Vitamin B3): Supports energy metabolism and skin health.
- Riboflavin (Vitamin B2): Important for energy production and maintaining healthy skin, eyes, and red blood cells.

Additional, red meats, particularly organ meats, can be a source of vitamin A, which is crucial for vision, immune function, and skin health. White meats, such as poultry, are also rich in B vitamins, including vitamin B6 (pyridoxine), which supports brain health and the formation of neurotransmitters (Pereira , 2013).

5. Meat carbohydrates

Red and white meats are primarily sources of protein and do not contain significant amounts of carbohydrates. The carbohydrate content in meat is generally minimal, as meats are composed mainly of protein, fat, and water. Red and white meats, such as beef, poultry, and fish, contain negligible amounts of carbohydrates. The carbohydrate content in raw, unprocessed meat is typically less than 1 gram per 100 grams of meat. Some processed meat products, like sausages or meat-based spreads, might contain small amounts of added carbohydrates due to fillers, binders, or flavorings, but the carbohydrate content is still relatively low compared to other food sources.

In conclusion, this review study showed the variation between red and white meat involves a diverse array of characteristics that extend beyond color alone. While red and white meats are both valuable sources of protein, their nutritional profiles, health implications, and culinary applications exhibit notable disparities that warrant consideration. Red meats, which include beef, and lamb, tend to be richer in certain nutrients such as iron, zinc, and vitamin B12. However, their higher fat content, particularly saturated fat, has led to discussions about their potential impact on cardiovascular health when consumed excessively. On the other hand, white meats like poultry offer leaner options with lower saturated fat content, making them a popular choice for those seeking to maintain a heart-healthy diet. Additionally, the muscle fiber composition and metabolic characteristics of red and white meats contribute to their distinctive functional roles. Red meats, often derived from muscles used for power and endurance, exhibit greater myoglobin content, resulting in a deeper color and more pronounced flavor. This also influences their cooking techniques, with many red meats benefiting from slower, more gentle methods to enhance tenderness and flavor. In contrast, white meats are predominantly found in muscles used for shorter bursts of activity, resulting in a lighter color, milder flavor, and quicker cooking times. Culturally, the preferences for red or white meats are influenced by culinary traditions, dietary choices, and even ethical considerations. Sustainable sourcing, animal welfare, and environmental impact have prompted individuals to explore alternatives such as plant-based proteins or lean poultry. Moreover, the nutritional implications of red and white meats extend beyond individual health, as their production systems can impact factors such as greenhouse gas emissions, land usage, and water consumption.
In the realm of health, it's essential to consider moderation and dietary diversity. Incorporating both red and white meats, along with other protein sources such as fish, legumes, and nuts, can contribute to a balanced diet. Making informed choices about

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portion sizes, cooking methods, and cuts can help optimize the nutritional benefits while minimizing potential drawbacks. Eventually, the choice between red and white meats should be based on individual preferences, dietary goals, and overall health considerations. By understanding the nuanced differences between these two categories of meats, individuals can make informed decisions that align with their nutritional needs and values, contributing to a well-rounded and enjoyable culinary experience.

Competing interests

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