

## Poultry meat quality: technological, nutritional, sensory and microbiological quality

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### Abstract:

Meat is a foodstuff rich in protein also it's very important for human nutrition. The quality is the set of characteristics conferred on it by its nutritional, technological, organoleptic and microbiological properties. The concept of meat quality is a complex concept that encompasses a multitude of different properties that can be influenced by the producer, the processor and even the consumer during the final preparation of the meat. The main objective of this review is to present the qualities of the meats consumed. This article also reviews the point of production and consumption of poultry meat in Tunisia. Meat quality data was collected from researched scientific publications.

**Key words:** poultry, quality, technological, nutritional, sensory, microbiological.

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### I. Introduction

Global consumption of poultry meat, especially chicken, has exceeded that of other meats in recent decades<sup>1</sup>. Chicken meat is the second largest source of consumed meat protein, has high edible and nutritional value, widely appreciated by consumers, and its demand is increasing<sup>2</sup>. Chicken meat is one of the best sources of animal protein for low-income populations because it is affordable, accessible, low in fat, and has limited religious restrictions<sup>3</sup>. Human health, nutrition and animal welfare are increasingly attracting consumer attention and organic food markets are growing in popularity. Poultry products, which are an important food source worldwide they, are also experiencing growth in the organic market. In addition to quantity, quality has become a real challenge for producers and processors who must meet local and international requirements. Thus, several scientific research works have been carried out to evaluate and improve the meat's quality which is produced and consumed in Tunisia.

### II. Evolution of chicken meat production in Tunisia

The production of chicken meat in Tunisia for the past fifteen years has increased (Figure 1). The year 2019 recorded the highest value of 137.5 tons<sup>4</sup>.

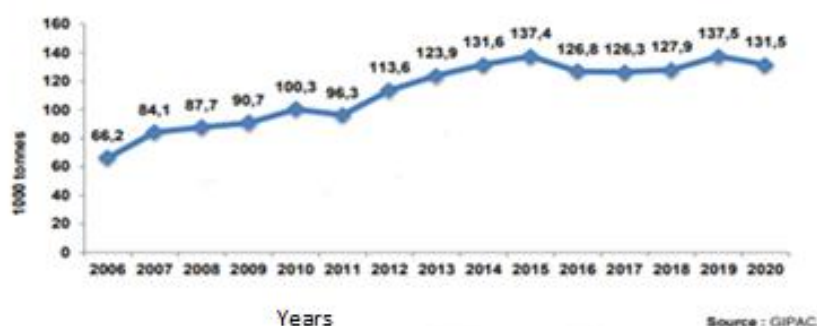
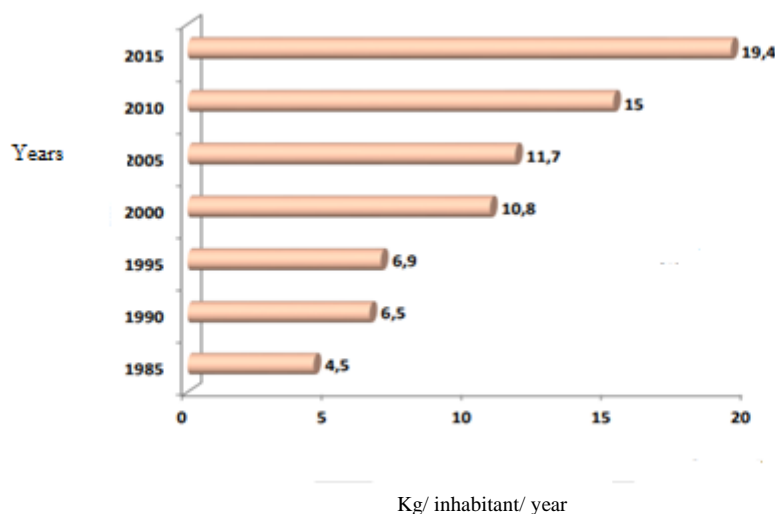


Figure1. Evolution of chicken meat production in Tunisia<sup>4</sup>

### III. Evolution of chicken meat consumption in Tunisia

Chicken meat consumption in Tunisia is increasing every year. Consumption by inhabitant by year, in 2015 is estimated at 19.4 kg, for chicken meat<sup>5</sup> (Figure 2).



**Figure2.** Evolution of chicken meat consumption in Tunisia<sup>5</sup>

### IV. Concept of meat

Meat is the result of postmortem evolution of skeletal muscle tissue and adipose tissue. It is the product of transformation of the muscle after the death of the animal<sup>6</sup>.

#### Mechanism of transformation of muscle in meat

When the animal dies, the muscle which was initially flexible undergoes many transformations to become meat. These transformations generally go through the panting phase, the rigor mortis phase and the maturation phase. The panting phase or the panting state begins with the cessation of blood circulation which suppresses the supply of oxygen and exogenous energy substrates (glucose, amino acids and fatty acids). Cellular oxidative power decreases very rapidly, and only anaerobic reactions (mainly glycolysis) persist<sup>7</sup>.

Glycogen is transformed into lactic acid. The progressive acidification of the muscle associated with its hardening characterizes the installation of the phase of rigor mortis also called rigor mortis which appears a few hours after death in cattle whose carcass is subjected to refrigeration<sup>6</sup>.

As for maturation, it is the phase of favorable evolution of tenderness and results from the degradation of certain elements of the muscle fiber (rupture of the Z streaks and elongation of the sarcomeres) or of the connective tissue by proteases<sup>7</sup>. During this progressive muscle degradation, various factors (including meat aroma and flavor precursors) responsible for the organoleptic quality of meats are elaborated in a series of complex processes<sup>8</sup>. From the panting state to maturation, muscle hardness increases rapidly before gradually falling to an acceptable level to give the meat good organoleptic qualities.

#### The composition of the meat

Meat is composed of water, proteins (including enzymes) and amino acids, mineral salts, fats and fatty acids, vitamins and other bioactive components, and small amounts of carbohydrate. Protein represents 12-20% of the edible part and 50-80% of the dry weight. The main ones are myosin, myostroin and collagen. Myoglobin gives meat its characteristic red color which turns brown upon oxidation. The lipids are in very variable quantity according to the animal and the piece: 5p 100 for the chicken; 5-10p 100 for veal, rabbit; 10-20p 100 for charcuterie<sup>9</sup>.

### V. Meat quality

According to the International Standard Organization, quality is defined as "all the properties and characteristics of a service or product which give it the ability to satisfy expressed or implicit needs". For the consumer, the quality of a food can be defined from a certain number of organoleptic characteristics<sup>8</sup>.

### VI. Poultry meat quality criteria

#### 1. Nutritional Quality

The main components of raw poultry meat are proteins, lipids and minerals in proportions between 18.4 and 23.4%, 1.3 and 6.0%, 0.8 and 1.2% respectively<sup>10</sup>. Breast meat contains less than 3 g fat/100 g and the

corresponding average value for dark meat (without skin) is 5-7 g/100 g. Unlike beef fat and dairy products, chicken meat does not contain trans fats<sup>11</sup> that contribute to coronary heart disease and about half of the fat is made up of the desirable monounsaturated fats, and only a third of the less healthy saturated fats. The World Cancer Research Fund and other<sup>12</sup> suggested that consuming large amounts (more than 500g/week) of red meat, especially processed meat, but not chicken meat, may be unhealthy.

Poultry meat is an important supplier of essential polyunsaturated fatty acids (PUFAs), especially  $\omega$ -3 fatty acids<sup>13</sup>. The amounts of these important fatty acids, particularly long-chain polyunsaturated fatty acids (LC PUFAs), can be increased more easily in chicken meat than in other farmed meats, although negative effects on oxidative stability may appear.

## **2. Technological quality**

The technological characteristics represent the suitability of the meat for preservation and processing<sup>14</sup>.

### **pH**

pH has a direct impact on meat quality attributes such as tenderness, water holding capacity, color, juiciness and shelf life. High pH broiler breast meat has a higher water-binding capacity than lower pH meat.

The pH of broiler meat is a function of the amount of glycogen in the muscle before slaughter and the rate of conversion of glycogen to lactic acid after slaughter. Color identification is an easy way to determine the pH of meat. If the meat is very dark it will have a high pH and if it is very light it will have a low pH<sup>15</sup>. The lighter than normal fillets had an initial pH of 5.8, a moisture absorption of 6% when marinating, a drip loss of 5.88% and a cooking loss of 34.4%. Darker than normal fillets had an initial pH of 6.02, marinating pick-up of 7.67%, drip loss of 3.34%, and cooking loss of 32.9 %, which shows a significant impact on drip loss.

Poultry meat with low pH has been associated with low water-binding capacity (WRC), which results in increased cooking loss, drip loss, cooking time, preservation and a reduction in tenderness<sup>16</sup>.

### **The power of water retention**

Water retention capacity or water retention capacity is the ability of meat to firmly retain its own water or added water when applying any force. It is essential to take this parameter into account because it influences the profitability of the processing sector and more importantly, the organoleptic qualities of the meat, moreover this parameter is often considered by the consumer as a quality criterion, even sometimes is wrongly, as an indication of treatment of animals by growth promoters. It is therefore necessary to determine the water retention capacity during storage but also during cooking. It is also possible to estimate the loss by evaporation or sublimation during storage<sup>17</sup>.

## **3. Organoleptic quality**

The organoleptic characteristics of meat include the sensory properties at the origin of the sensations of pleasure associated with their consumption. The sensory quality of meat is determined by its color, flavor, juiciness and tenderness<sup>18</sup>.

### **Color**

The color of the meat is the first qualitative characteristic perceived upon purchase. The consumer considers it as a criterion of product freshness<sup>8</sup>. It is the result of four components, the first and the second one explain the color of the fresh product, the third and the fourth one, its evolution during storage<sup>19</sup>.

The structural component of color is linked to the physical structure of the muscle and in particular to its degree of acidification (pH), which modifies the luminosity of the product (more or less light red)<sup>20</sup>.

The quantitative component, i.e. the amount of red pigment in the muscle, which determines the color saturation (bright red or dull, grayish). Myoglobin (carrier of oxygen in the muscle) is the main pigment responsible for the color of meat. It is a chromoprotein made up of a heme group containing heme (iron atom associated with protoporphyrin) and a protein, globin. A higher heme iron content is associated with less light meat with higher red intensity and lower yellow intensity. During conservation, the structural and quantitative components change little<sup>20</sup>.

The qualitative component, relating to the chemical form of muscle pigment, which evolves over time. Reduced myoglobin (MbO<sub>2</sub>, Fe<sup>++</sup>) corresponds to the pigment deep in the muscle or on the surface of the meat when it is stored in the absence of oxygen, exposed to air, the pigment combines with oxygen to form bright red oxymyoglobin (MbO<sub>2</sub>, Fe<sup>++</sup>), synonymous with freshness and attractive to consumers<sup>20</sup>.

Meat color appears redder and darker with increasing age<sup>21</sup> and carcass weight<sup>22</sup> and nature of diet<sup>23</sup>, muscle metabolic type and muscle fiber composition<sup>24</sup>, marbling rate and heme pigment content in the period immediately preceding slaughter (stressful conditions) and the period post mortem<sup>25</sup>, also influence the color of the meat.

### **Flavor**

The flavor of the meat corresponds to "all the olfactory and taste impressions" that one experiences at the time of tasting. The various chemical compounds responsible for the flavor of meat are released mainly during cooking<sup>26</sup>

### **Tenderness**

Tenderness can be defined as the ease with which a meat can be sliced and chewed, unlike hard meat, which is difficult to chew<sup>27</sup>. Tenderness is the most important quality criterion for the consumer when consuming meat. It measures the ease with which the structure of meat can be disorganized during chewing<sup>28</sup>. Tenderness is an important quality factor. It is the most determining sensory quality for meat consumers<sup>29</sup>. It is also one of the most variable quality criteria of multifactorial origin, and therefore the most difficult to control or predict<sup>30</sup>.

### **Juiciness**

The correctness or impression of juice release during chewing is linked to the amount of free water found in the meat and to the secretion of saliva stimulated essentially by lipids<sup>31</sup>. According to Youssao et al<sup>32</sup>, the accuracy of the meat varies according to the level of intramuscular lipids. It is also influenced by muscle characteristics such as pH and muscle water retention capacity<sup>18</sup>.

## **4. Microbiological quality**

### **Total mesophilic aerobic flora**

The Total mesophilic aerobic flora (TMAF) corresponds to hygiene indicator bacteria. It includes pathogenic microbes and spoilage microbes. The TMAF count is an excellent method for estimating the food safety and quality index<sup>33</sup>. It provides information on the overall microbial load of the food, thus reflecting its microbiological quality<sup>34</sup>.

This flora is able to multiply aerobically, at average temperatures, more precisely those whose optimum growth temperature is between 25 and 45°C. It quickly leads to spoilage and makes food unfit for consumption<sup>35</sup>. A mesophilic flora found in large quantities indicates that the meat spoilage process has begun and is a reflection of poor general hygiene conditions.

### **Total coliforms**

Coliforms are indicators of hygienic quality<sup>36</sup>. The term coliforms corresponds to rod microorganisms, non-sporogonia with Gram-negative, oxidase-negative staining, aerobic or optionally anaerobic, possessing the enzyme  $\beta$ -galactosidase allowing the hydrolysis of lactose at 35°C and capable of growing in the presence of bile salts. Total coliforms have long been used as indicators of microbial water quality because they can be indirectly associated with faecal pollution.

Almost all of the species are non-pathogenic and do not represent a direct health risk<sup>36</sup>, with the exception of certain *E. coli* strains, as well as rare opportunistic pathogenic bacteria. In very high numbers, they can cause food poisoning.

### **Faecal coliforms**

Faecal coliforms, or thermotolerant coliforms, are a subgroup of total coliforms capable of fermenting lactose at a temperature of 44.5°C. These coliforms are telltale germs of faecal contamination. The count of faecal coliforms makes it possible to monitor the hygiene of meat handlers. The species most frequently associated with this bacterial group is *E. coli*<sup>37</sup>. However, the *E. coli* bacterium represents 80 to 90% of the thermotolerant coliforms detected. Although the presence of faecal coliforms usually indicates contamination of faecal origin, several faecal coliforms are not of faecal origin, coming rather from water enriched in organic matter, such as industrial effluents from the pulp and paper sector or food processing<sup>38</sup>. These germs can become pathogenic for the consumer when they are present in large numbers.

### **Escherichia coli**

*E. coli* is a bacterium, prokaryotic organism belonging to the Enterobacteriaceae family, they are normal or pathological bacteria of the digestive tract.

They are found in the soil and plants which are even the usual shelter of certain species. *E. coli* also lives in the intestines of humans and some healthy warm-blooded animals. It is a rod-shaped bacterium, its size varies according to the growth conditions (between 0.5 and 3  $\mu\text{m}$ ). It is an optional aero-anaerobic Gram-negative bacillus, asporulated, sometimes encapsulated, and resists heat well; severely reduced peritrichous mobility. This bacterium grows in a wide range of pH between 4.4 and 9, with an optimum of 6 to 7, for a value of water activity (*A<sub>w</sub>*) of 0.95 minimum and in a temperature interval of 10°C to 45°C with an optimum at 37°C. The majority of its strains are harmless, cause no symptoms, but some are pathogenic and cause intestinal

disorders. *E. coli* was identified in 1885 by Theodor Escherich. *E. coli* are routinely characterized by serological identification of their somatic O, flagellar H and capsular K antigens. They are abundant in the stool and are sought as such as a witness of faecal contamination in water and food<sup>39</sup>.

### **Staphylococcus aureus**

These are presumed pathogenic staphylococci. They are represented by *Staphylococcus aureus* and are of human origin. These are germs whose count reflects the presence of carriers in the broiler meat circuit. Appearance-wise, staph colonies are large, opaque, creamy white or golden in color, but under the microscope they appear as cocci (rounded) arranged in a cluster. A major distinction must always be made within the genus *Staphylococcus*: *Staphylococcus epidermidis* with coagulase (-) having a white pigment (white staphylococcus) is a commensal germ of the skin and mucous membranes, rarely pathogenic. *Staphylococcus aureus* with coagulase (+) which has a yellow pigment (*staphylococcus aureus*), is a pathogen very frequently isolated in human pathology<sup>40</sup>.

### **Salmonella spp**

*Salmonella* are bacteria belonging to the Enterobacteriaceae family. They are straight Gram-negative bacilli; and they are motile, except all strains of serovar Gallinarum. These 2 to 3 µm long rods are mesophilic bacteria, which are not very demanding from a nutritional point of view. Their development is optimal for temperatures close to the body temperature of warm-blooded animals, 35 to 37°C, and a pH of 6.5 to 7.5. Their multiplication remains assured for temperatures of 6.7 to 41°C. The wide spectrum of temperatures -20 to 60°C and pH 4.1 to 9 at which they are able to survive, as well as their ability to withstand an Aw value of 0.94, make them extremely resistant bacteria to harsh conditions. even difficult environmental conditions (freezing) and explain their ubiquitous nature<sup>41</sup>. *Salmonella* are mainly found in the intestines of humans and animals and in natural environments polluted by human or animal excrement. All varieties of food are likely to be contaminated, but they are mainly found in polluted waters and products eaten raw. The vast majority of *Salmonella* isolated from humans and warm-blooded animals belong to the Enterica subspecies. *Salmonellae* are distinguished from each other by the expression of their multiple somatic (O), flagellar (H) and capsular (K) antigens, and by their different biochemical profiles. *Salmonella* multiply in the digestive tract of the colonized host. They therefore multiply little or not at all in the environment, but they are excreted there in large numbers through the faeces of patients or healthy carriers.

## **VII. Conclusions**

The concept of meat quality is a complex concept that encompasses a multitude of different properties that can be provided by the producer, the processor and even the consumer during the final preparation of the meat. The parameters of variation in the quality of poultry meat are the subject of numerous studies. Many measurement methods exist to assess the quality of the carcass and the meat. Despite the variation in the criteria for assessing the quality of meat by consumers, there is in most cases consistency between the values of these assessment criteria and those of the measurement methods.

In short, the subjective criteria of the quality of the carcass and those of the meat correspond to the judgments that the consumer makes on the meat before the purchase decision and during consumption. These criteria are diversified and vary from one continent to another or from one community to another and are related to image and social values. They vary according to consumer behavior and preferences. On the other hand, the objective criteria relate to technically measurable parameters on the meat and usable in routine in order to be able to diagnose non-conformities in real time and to initiate, if necessary, actions. The technological, nutritional, organoleptic and sensory characteristics of meat from local hens in northern North Africa are not known. A characterization of the carcass composition and quality of poultry meat from North Africa is necessary so that the meats are better known by consumers and more competitive on the international level.

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