

Current meat quality challenges for the poultry industry – a review*

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Poultry meat consumption has increased substantially over the last decades and the lifestyle changes have also dramatically modified the way, in which poultry meat is marketed and consumed. Therefore food technologies have become part of the poultry industry and today much of the production is marketed in the form of cut-up and processed products. The global success of chicken meat is made possible by its affordability, nutritional and sensory properties, ease of preparation as well as the absence of religious restraints. Poultry meat consumption is expected to further increase in the near future. However, in addition to well-known issues such as microbiological hazards associated with poultry meat consumption, welfare problems as indirect effects of artificial selection for high growth-rate, negative consumer attitudes towards intensive production systems, also increased consumers' perception of undifferentiated products and progressive loss of nutritional biodiversity of the meat should be not overlooked.

KEY WORDS: poultry meat / raw materials / processing / quality

Nowdays global meat production derives from a very limited number of mammal and bird species, as almost 90% is obtained from chickens (35.4%), pigs (32.6%) and cattle (20.4%) – FAO [2021]. Overall, this shows the gradual loss of biodiversity in the human diet, which is increasingly based on a few animal and plant species [Lachat

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et al. 2018, FAO, 2019]. Within this context, poultry production and consumption have increased substantially over the last decades and nowadays poultry meat is one of the primary animal protein sources for many people in a majority of countries (Fig. 2) – OECD/FAO [2021]. The universal success of chicken meat is made possible by its affordability, nutritional and sensory properties, ease of preparation as well as the absence of religious restraints [Baldi *et al.* 2020].

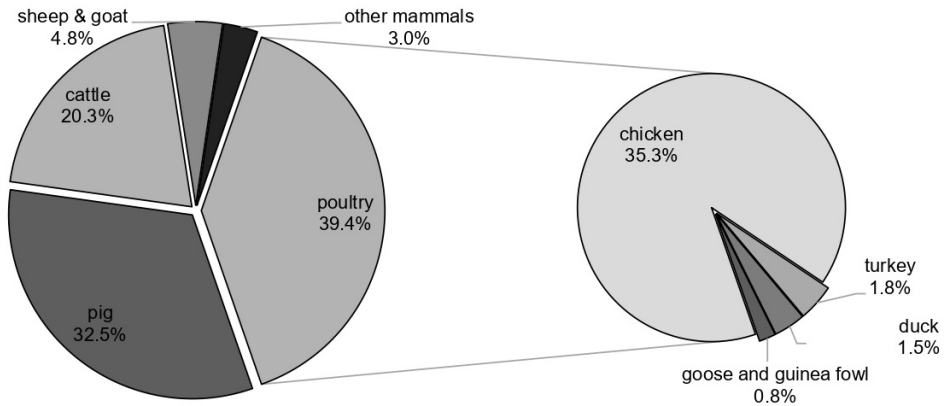


Fig. 1. Production of meat produced in the world. Own design, data source: FAO [2022].

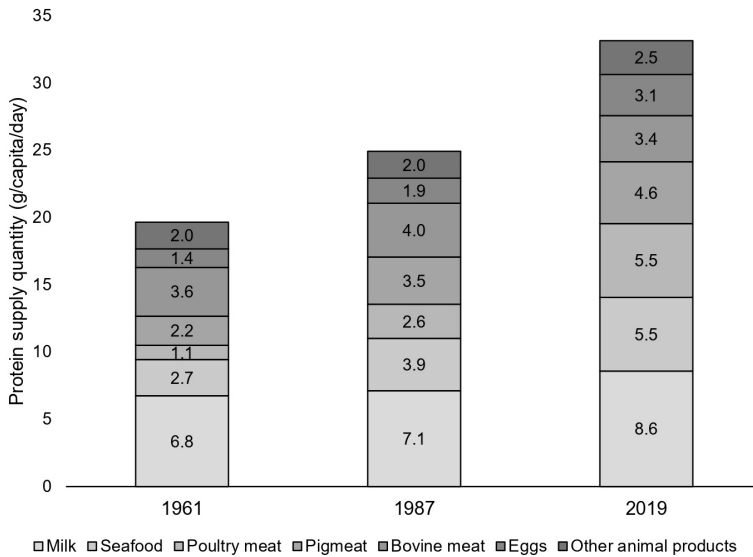


Fig. 2. Evolution from 1961 to 2019 of the global animal protein supply quantity. Own design, data source: FAO [2022].

The development in industrialization and specialization of broiler meat production chains that took place starting from the end of World War II allows to obtain huge advancements in both the efficiency and quality of chicken meat production [Maharjan *et al.* 2021, NCC, 2022] – Table 1. In addition, over the last decades the lifestyle changes have also dramatically modified the way, in which poultry meat is marketed and consumed. Therefore food technologies have become part of the poultry industry and today much of the production is marketed in the form of cut-up and processed products [Baldi *et al.* 2020]. Indeed, due to the shift of consumers’ propensity to the convenience of ready-to-cook meals, nowadays almost half of the American meat market involves the commercialization of processed products [NCC, 2022] – Table 1.

Table 1. Progress in broiler performance and evolution of market segments and forms of chicken meat in the US (adapted from NCC, 2022)

| Year | Live performances | | | | Market segments | | | Market forms | |
|------|-------------------|--------------------|------------------------|---------------|--------------------|------------------|-----------|------------------|---------------|
| | market age (d) | market weight (kg) | feed to meat gain (kg) | mortality (%) | retail grocery (%) | food-service (%) | whole (%) | cut-up parts (%) | processed (%) |
| 1940 | 85 | 1.30 | 4.0 | 12 | - | - | - | - | - |
| 1950 | 70 | 1.40 | 3.0 | 8 | - | - | - | - | - |
| 1960 | 63 | 1.52 | 2.5 | 6 | - | - | 78 | 19 | 3 |
| 1970 | 56 | 1.64 | 2.25 | 5 | 75 | 25 | 70 | 26 | 4 |
| 1980 | 53 | 1.78 | 2.05 | 5 | 71 | 29 | 50 | 40 | 10 |
| 1990 | 48 | 1.98 | 2.00 | 5 | 59 | 41 | 18 | 56 | 26 |
| 2000 | 47 | 2.28 | 1.95 | 5 | 58 | 42 | 10 | 44 | 46 |
| 2010 | 47 | 2.59 | 1.92 | 4 | 56 | 44 | 12 | 43 | 45 |
| 2020 | 47 | 2.91 | 1.79 | 5 | 55 | 45 | 9 | 40 | 50 |

Because of this market change, the genetic background of modern meat-type chickens has been profoundly adapted by increasing meat yield and the proportion of high-value parts such as breast [Petracci *et al.* 2015, Tixier-Boichard 2020]. This condition has been well represented by comparing body composition of a chicken

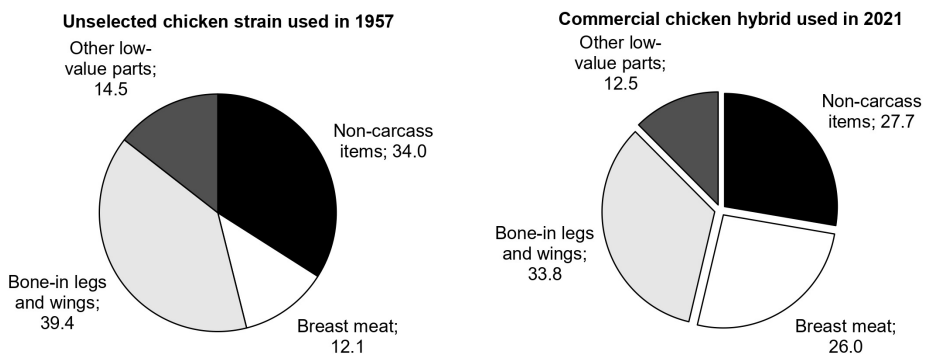


Fig. 3. Comparison of the yield of body parts in chicken genotypes used for commercial purposes in 1957 (unselected) and 2021 (fast-growing hybrid). Own design, Data from Havenstein *et al.* [2003] and Aviagen [2021].

genotype used for commercial purposes in the 1950s [Havenstein *et al.* 2003] with those adopted today [Aviagen 2021], as shown in Figure 3. Nowadays, it is estimated that deboned breast and leg meat (without skin and bone) may reach up to 47% of live weight in big birds [Aviagen 2021]. This is contributing to partially counteracting the potentially increased proportion of by-products generated at an industrial level due to consumer preference towards trimmed, deboned, ready-to-cook, partially or fully cooked processed products [Baldi *et al.* 2021].

As a result of this transition to industrial production, nowadays the poultry industry has evolved into one of the most integrated agricultural industries. In most countries the broiler industry is entirely vertically integrated from breeding flocks and hatcheries to feed mills, transportation divisions, slaughter and processing facilities. Through both vertical integration and mergers the number of firms operating in the broiler industry is continuously declining in main producing countries [Vukina 2001, Unveren & Luckstead 2020]. When combined, it is estimated that in 2021 the top 20 broiler producers in the world slaughtered almost 18.3 billion of birds (WATT). In addition, most of the world’s production is currently based on intensive farming of very few fast-growing hybrids (i.e. Ross, Cobb and Hubbard) rapidly reaching the slaughter weight and having high meat yields [Tixier-Boichard 2020]. In addition to the genetic profile of the animals, the farming techniques and composition of the broiler diets also gradually tends to be uniform worldwide [Baeza *et al.* 2021]. As a consequence, differences existing in meat quality among broilers produced by different companies and in individual countries are very limited when compared to those observed in the case of beef and pork. Therefore, the reduction of nutritional biodiversity and progressive homogeneity of chickens are even more dramatic compared with other foods of animal origin [Hanley-Cook *et al.* 2021]. Standardization in chicken meat



Fig. 4. Main strategies for product differentiation in the poultry sector at primary production and processor levels.

production is also limiting the mechanisms differentiating quality or origin of the product and for several years now final consumers have been gradually perceiving chicken meat as an undifferentiated product. By the nature of commodity products, each unit is a near perfect substitute for the next one. As a result, there are increasing attempts to differentiate products based on the origin of the birds, as summarized in Figure 4. In some countries also different alternative systems may be found, using outdoor extensive rearing conditions and slow-growing lines [Baeza *et al.* 2021].

On the other hand, standardized quality traits make chicken meat an excellent raw ingredient for large-scale production of a large variety of processed products, in which differences in ethnic, religious and local customs have resulted in a multitude of ways that the meat and other edible parts can be incorporated in further processed products [Fletcher 2008, Barbut 2015, Baldi *et al.* 2021]. When compared with red meats, poultry meat is fit for development of further processed products because of its bland flavour and soft texture, which allow producers to impart desired flavour profiles and textures according to market/marketing needs and target consumers [Petracci *et al.* 2013]. Further processing allows to obtain a high degree of product differentiation and the main current market trends are summarized in Figure 2.

Over the last decades, poultry meats have been processed and packaged at central facilities and delivered to retailers ready to be placed in display cases [Dawson 2010, Chowdhury & Morey 2019]. Case-ready poultry meats are packaged in transparent packages, in which appearance is the main criteria of selection and largely affects willingness to buy [De Carvalho *et al.* 2020]. Due to the market transition toward processed products, traditional carcass quality issues, such as missing parts, broken bones, skin tears, scratches, surface discolourations, inconsistent pigmentation or the so-called skin barking, and bruises are still important only for the whole bird and parts market, but they are not as critical for much of the food service or further processing industries. On the other hand, meat quality traits such as appearance, texture, juiciness and flavour are becoming increasingly important both for the selection of a product and the consumers' final evaluation of meat eating quality [Fletcher 2002, Petracci *et al.* 2010]. The shift towards further processed products has also stressed the necessity for higher standards in poultry meat quality in order to improve sensory characteristics and functional properties [Fletcher 2002].

Sold poultry products are currently prepared from a variety of meat sources (i.e. light and dark meat, mechanically deboned meat) and key quality traits of these materials are very different if final products are sold raw or cooked, as summarized in Table 2. Raw products include bone-in, boneless, skin-on and skinless carcass parts (i.e. breast fillets, tenderloins, drumsticks, thighs and wings) and uncooked processed products such as enhanced whole-muscle and those produced with minced meat (i.e. sausages, patties, meat balls and meatloaves), in which water, salts and other food additives are added [Fletcher 2004, Petracci *et al.* 2013]. Cooked products include a large variety of items, which can be prepared with whole parts (i.e. roasted and breaded parts) or comminuted meat (i.e. burgers, bologna, frankfurters) – Fletcher

Table 2. Key poultry meat quality traits for the industry

| Uncooked products kept refrigerated (raw meat) | Cooked products kept refrigerated (and frozen items) |
|--|---|
| <ul style="list-style-type: none"> – stability (microbial) which affects shelf-life – appearance/colour (uniformity and discoloration) / water holding capacity (liquid inside the package) – critical especially for consumers’ initial selection – taste/tenderness (most important affecting final quality assessment) and juiciness – water binding capacity (yield – only for water added products) | <ul style="list-style-type: none"> – water binding capacity (yield and sensory traits) – microbial and chemico-physical stability (mostly affected by oxidation of fats and proteins) which affect shelf-life, appearance and flavour – texture, juiciness and aroma |

[2004] and Barbut [2012]. Both types of products are sold fresh or frozen. In addition to microbial shelf-life, susceptibility of the meat components toward oxidation (i.e. heme pigments, fatty acids, myofibrillar proteins) both during refrigerated and frozen storage is the main current quality issue. As a consequence not only researchers, but also industry operators are looking for solutions to alleviate these problems [Estevez 2015, Baeza *et al.* 2021].

In virtually all areas of primary and further processing, processors also require uniform raw materials to improve the efficiency of production and consistency of product quality [Barbut 2015]. However, poultry processors have to deal with a certain variability of raw meat quality caused by ante-mortem and early post-mortem factors [Petracci *et al.* 2010]. This is especially associated with the occurrence of pale-soft-and-exudative-like and dark-firm-dry meat defects, which affect both broiler and turkey meat. These abnormalities impair the visual quality of uncooked products and negatively affect technological quality of meat when incorporated in processed products [Petracci *et al.* 2017, Zampiga *et al.* 2021]. In addition, during the last few years an increased occurrence of growth-related abnormalities (white striping, wooden breast and spaghetti meat) is increasing variability in the chemical composition and protein functionality for further processing of raw materials. Because of the altered visual appearance, poultry plants tend to downgrade abnormal breasts and potentially divert the meat into processed cooked products. Reduced protein quality and functionality also impair processing abilities, especially when used for high-quality processed products [Petracci *et al.* 2019, Baldi *et al.* 2020]. Tremendous research efforts have been devoted to identify underlying mechanisms and mitigation strategies for growth-related abnormalities at the farm and processing levels and explore possible nutritional intervention strategies to reduce the incidence of these abnormalities [Petracci *et al.* 2019]. Recently, an extensive review paper confirmed that myopathic disorders affecting pectoral muscles of fast-growing broilers have a complex etiology, with several biological pathways, as well as response mechanisms being involved in their development [Soglia *et al.* 2021]. Researchers are now trying to establish if current levels of breast yield and growth rates reached by artificial selection in modern hybrids are still compatible with maintaining proper muscle growth and high meat quality irrespective of the occurrence of growth-related abnormalities.

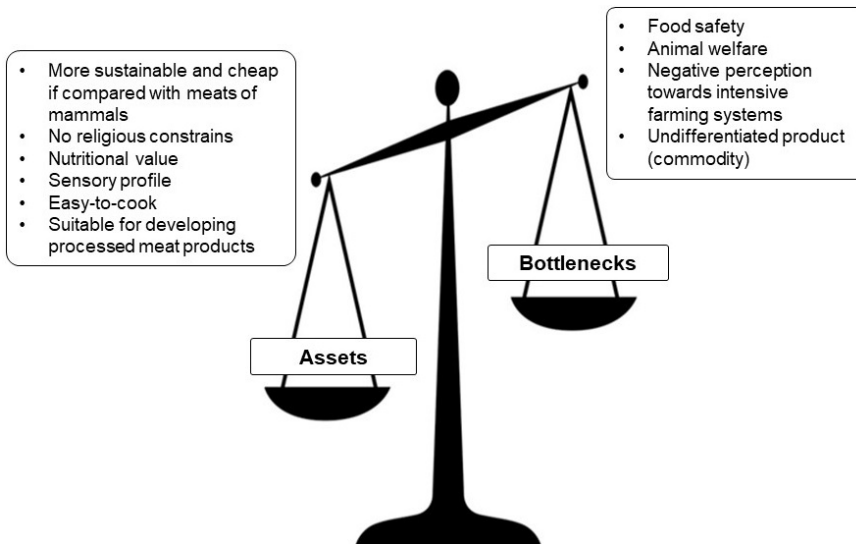


Fig. 5. Opportunities and bottlenecks for further expansion of poultry meat consumption.

In conclusion, current forecasts and projection studies point out that the poultry market will keep growing in the future [OECD/FAO, 2021]. One of the main driving forces is that the price of chicken and turkey meat is very competitive in comparison with red meats because of the much higher production efficiency and lower production costs. However, further other assets can be identified beyond the price, as previously discussed and summarized in Figure 5. Additionally, in addition to well-known issues such as microbiological hazards associated with poultry meat consumption, welfare problems as indirect effects of artificial selection for high growth-rate, negative consumer attitudes towards intensive production systems, also increased consumers' perception of undifferentiated products and progressive loss of nutritional biodiversity of the meat should not be overlooked.

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