Physico-chemical, colour parameters and textural traits of raw duck breast

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Introduction

In recent time, there are some important factors influencing meat and meat products choice of consumer mainly related to health concern (fat content, production of leaner animals), appearance factors (visible fat), development of low fat meat products (low fat formulation), demographic influences (income, age, ethnicity, convenience, change in distribution, price) and new product development (restructured meat products, low-salt products, vacuum-packaged meat products) (Resurreccion, 2003).

It is not easy to find duck meat and duck meat product in the market. It happens because there are not many modern duck rearing farms and finally it causes the duck meat and meat product just have little expose among society (Putra, Huda, and Ahmad, 2008).

Water holding capacity, pH and chemical composition, usually determinated in breast and leg muscle are crucial for the culinary value and technological properties of duck meat and have been investigated by many authors in relation to the bird origin, age and nutrition (Witkiewicz, 2000; Woloszyn *et al.*, 2002). Thus, the aim of the work was to evaluate chemical parameter like proximate composition, texture analysis and colour parameters of duck breast.

Material and Methods

Animals, rearing conditions and procedures for dry-cured breast duck

Male ducks (n=10) from crossbred mule were used in this study. They were reared under usual conditions of light and temperature at the Anades Galicia, S.L. (Vilardevos, Spain). Animals were fed "*ad libitum*" for 14 weeks with a restricted commercial concentrate. After this period, animals were overfed with boiled corn for 16 days. Ducks were slaughtered humanely in a commercial meat processing company (Anades Galicia, S.L., Vilardevos, Spain). Carcasses of around 3 kg were chilled for 48 hours at 4 ºC. Breast, with an average weight of 0.4 kg from duck carcasses were excised.

Analytical methods

pH, colour, heme-iron content and chemical composition

The pH of samples was measured using a digital pH-meter (Thermo Orion 710 A+, Cambridgeshire, UK) equipped with a penetration probe. A portable colorimeter (Konica Minolta CR-600 Osaka, Japan) was used to measure meat colour in the CIELAB space (CIE, 1976). (lightness, L*; redness, a*; yellowness, b*).). Heme-iron was measured in duplicate, according to the methodology of Hornsey (1956) with the following formula (Merck, 1989):

Hematin (μg hematin/ g muscle) = Absorbance × 342.44

Heme iron (mg/100 g meat) = (Hematin x 8.82)/100

Moisture, fat, and protein (Kjeldahl N x 6.25) were quantified according to the ISO recommended standards 1442:1997 (ISO, 1997), 1443:1973 (ISO, 1973), and 937:1978 (ISO, 1978) respectively. Total chlorides were quantified according to the Carpentier-Vohlard official method (ISO 1841-1:1996).

Water-holding capacity (WHC)

The WHC was measured by cooking loss (CL) according to describe by Franco *et al.* (2011). Steaks were cooked placing vacuum package bags in a water bath with automatic temperature control (JP Selecta Model Tectron Bio, Spain) until reached internal temperature of 70 ºC, controlled by thermocouples type K (Comark, PK23M, UK), connected to a data logger (Comark Dilligence EVG, N3014, UK). After cooking, samples were cooled at room temperature, placed in vacuum package bags in a circulating water bath at 18 ºC for 30 minutes and the percentage cooking loss was recorded.

Texture Profile Analysis (TPA)

The Texture Analyzer (TA-XT.plus, Stable Micro Systems, Vienna Court, UK) was used to conduct texture profile analysis (Bourne, 1978). Meat pieces of 1x1x2.5 cm (height x width x length) were used for texture analysis. Textural parameters were measured by compressing to 50 % with a compression probe of 19.85 cm^2 of surface contact. Force-time curves were recorded at a crosshead speed of 10 mm/s and recording speed was also 10 mm/s. Hardness (kg/cm^2), cohesiveness, springiness, gumminess (kg/cm^2) and chewiness (kg) were obtained. These parameters were obtained using the available computer software.

Statistical analysis

Standard deviation, minimum, maximum and mean values were calculated using the SPSS (SPSS 18.0, Chicago, IL, USA). Correlations between variables ($P<0.05$) were determined by correlation analyses using the Pearson´s linear correlation coefficient with SPSS 18.0 for Windows software package.

Results and discussion

Chemical composition, colour and textural parameters of duck breast are shown in Table 1. Mean pH values observed (5.94) were similar to those reported by Rammouz *et al.* (2004). Regarding to moisture, intramuscular fat and protein content we found mean values of 68.48, 1.54 and 24.29%, respectively. These values observed by us were lesser that described by Chartin *et al.* (2006) who found water levels of (72.08-74.99%) and intramuscular fat contents (3.09-6.40%) from duck breast of Pekin, Mule, Hinny and Muscovy breed. The moisture content of meat contributes to various meat palatability traites (juiciness and tenderness) and could have a negative effect on the flavour of meat as most flavour carrying components are hydrophobic (Lawrie, 1998; Priolo *et al.*, 2001; Jeremiah *et al.*, 2003). Juiciness, flavour and the texture (tenderness) of meat are considered as the main intrinsic factors influencing meat palatability and consumer acceptability (Bello and Calvo, 2000; Brewer and Novakofski, 2008). Beilken *et al.* (1990) concluded that consumers prefer meat that is tender and juicy, and that juiciness as well as flavour contributes to overall acceptability of the meat (Risvik, 1994).On the other hand, Intramuscular fat stimulates saliva secretions during mastication, increasing the sustained juiciness of the meat as perceived by the consumer (Lawrie, 1998). Intramuscular fat also has a positive effect on meat tenderness and flavour of meat.

Consumers perceive meat with a high percentage of cooking loss or shrinkage during cooking, as meat of poor or inferior quality (Barbera and Tassone, 2006). In our study, the WHC measured by cooking loss observed in our duck breast (22.96%) were higher than those found by Chartin *et al.* (2006) who described mean values of 21.08% for Pekin breed, 15.86% for Mule breed, 16.61% for Hinny breed and 16.98% for Muscovy breed. Jeremiah *et al.* (2003) concluded that a skeletal muscle with a high intramuscular fat content will have a low percentage of cooking loss and skeletal muscle containing a high concentration of moisture and insoluble collagen, will have a high level of cooking loss.

Instrumental colour of breast muscle showed a lesser luminosity (L*>38.5) and a higher redness (a*>18) and yellowness (b*>13). These results are agreement that reported by Salichon *et al.* (1998) who found that breast muscle of overfed mule duck was paler and had higher b* values than breast muscle of duck fed ad libitum. Fernandez *et al.* (2003, 2004) also reported that paler breast muscle of overfed mule duck and geese contained higher lipid levels. In general, during overfeeding, ducks ingest high amounts of corn containing liposoluble xanthophylls that accumulate in tissues and contribute to their colour.

Texture Profile analysis (TPA) also known as the double bite test, which simulate human mastication was developed to measure multiple sensory parameters (toughness, cohesiveness, gumminess, resilience, adhesiveness, chewiness, elasticity and springiness) (Bourne, 1978). Toughness is the most important parameter of meat and is defined as the samples resistance against compression. Resistance to compression will be high in a sample with high collagen content and low in a sample with a high percentage of intramuscular fat. Toughness is measured during the first cycle of compression, known as first bite (Bourne, 1978). Huidobro *et al.* (2005) concluded that TPA accurately predicts sensory texture parameters of cooked meat when the analysis is performed on raw meat and predicts toughness better than Warner Bratzler shear force (WBSF). The literature does not supply any data about TPA of duck breast. The hardness values of duck breast ranged from 2.62 to 0.64 kg/cm^2, the cohesiveness values ranged from 0.43 to 0.34, while the chewiness ranged from 0.37 to 0.07 kg.

Abtract

Physico-chemical properties (pH, moisture, intramuscular fat, protein, NaCl and Fe-hem), colour parameters (lightness, L*; redness, a*; yellowness, b*) and textural traits (hardness, springiness, chewiness, gumminess and cohesiveness) of ten raw duck breast were analyzed. Animals were fed "*ad libitum*" for 14 weeks with a restricted commercial concentrate. After this period, animals were overfed with boiled corn for 16 days. In general, the raw duck breast showed a higher mean values of pH (>5.90), a very lean meat (<1.60% in IMF) with a high protein content (>23.5%) and heme-iron (2.53 mg/100 g meat). Furthermore, the duck breast samples showed a lesser luminosity (L*>38.5) and a higher redness (a*>18) and yellowness (b*>13), and a low water holding capacity, measured by cooking losses (>22%). Finally, respect to TPA test, raw duck breast showed a lesser hardness (<1.8 kg/cm^2) and chewiness (>0.25 kg).

Keywords: Duck breast, physico-chemical properties, colour parameters, textural traits

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Table 1. Chemical composition, meat colour and textural properties of duck breast

	Mean ± S.D.	Range
Chemical Composition		
pH	5.94±0.07	6.02-5.84
Moisture (%)	68.48±1.54	70.14-66.71
Intramuscular fat (%)	1.54±0.87	2.55-0.31
Protein (%)	24.29±0.43	24.51-23.52
NaCl (%)	0.39±0.09	0.51-0.29
$Fe\text{-}_{hem}$(mg/100 g wet meat)	2.53±0.18	2.66-2.22
WHC		
Cooking Loss (%)	22.96±1.35	24.47-21.56
Colour Parameters		
Luminosity (L*)	39.98±2.94	42.47-35.01
Redness (a*)	18.23±0.69	19.32-17.66
Yellowness (b*)	13.69±2.46	16.79-11.08
TPA test		
Hardness (kg/cm^2)	1.79±0.80	2.62-0.64
Springiness	0.35±0.01	0.37-0.34
Chewiness (kg)	0.25±0.12	0.37-0.07
Gumminess (kg/cm^2)	0.70±0.35	1.05-0.20
Cohesiveness	0.39±0.04	0.43-0.34