



Effect of wooden breast myopathy on texture and acceptability of emulsified chicken patties

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Abstract Wooden breast (WB) condition is a chicken myopathy that causes quality losses and has been shown to negatively affect the sensory acceptance by consumers. In this work, we prepared emulsified chicken patties using WB meat and evaluated their texture profile and acceptability. Three formulations were processed: PN (100% normal breast), PW (100% WB meat) and PNW (50%:50% PN:PW). All the analyzed samples were in accordance with Brazilian legislation parameters for microbiological traits. A marked decrease ($P < 0.001$) of hardness was noted for PW and PNW samples compared with PN. The sensory ratings were not affected ($P > 0.05$) by the addition of WB meat in the different treatments. In fact, all samples presented a global sensory acceptance above 70%. The use of WB meat in the formulation of chicken patties is a useful practice to minimize the economic losses in the poultry

industry, also helping to support decision-making and improve production performance.

Keywords Myopathy · Wooden breast · Patties · Texture · Sensory acceptance

Abbreviations

WB	Wooden breast
PN	Normal patty
PW	Wooden breast patty
PNW	Chicken patty prepared with a mixture of normal and wooden breast meat
FIS	Federal inspection seal
TPA	Texture profile analysis
APHA	American Public Health Association
ERHBC	Ethics and Research with Human Beings Committee
AI	Acceptability index
Ma	Mean of the evaluated sensory attribute
ANOVA	Analysis of variance
ns	No significant difference

Introduction

The increasing demand for chicken meat because of its low cost, nutritional profile and sensory traits, has been driven the poultry sector to increase their productivity. To achieve this objective, it was necessary to enhance genetic selection in order to improve meat quality and growth rate of the birds (Petracci et al. 2017).

Despite the advances in the poultry industry, the high growth rate of the birds has been shown to negatively alter the muscular characteristics, such as diameter and length of the muscle fiber, besides also modifying the metabolism of

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the birds (Petracci et al. 2019). According Young and Rasmussen (2020), the time required to reach the commercial weight of the birds has been reduced with the genetic modification (from 43 to 35 days or less). Therefore, it is observed the presence of fibers of the type IIB in the *Pectoralis major* these broilers. In view of this observation, researchers hypothesized that accelerated bird growth may increase susceptibility to the development of myopathies such as wooden breast (WB) (Sihvo et al. 2014).

Wooden breast (WB) is the term attributed to a myopathy that affects the quality of chicken breast and which has already resulted, in combination with other myopathies, in economic losses of around US\$ 200 millions for the poultry industry in the United States (Kuttappan et al. 2017).

The WB myopathy mainly affects the *Pectoralis major* in poultry breasts, causing tissue damage. This condition is described as a muscle of hard consistency, pale color, bleeding points, tail protrusion and viscous liquid on the surface, and may be present at different levels of severity and in combination with other myopathies already known as White Striping e Spaghetti Meat (Petracci et al. 2019).

The occurrence WB myopathy has generated negative impacts on the appearance of the chicken breast fillets, and may also affect the technological properties, nutritional value and, consequently, consumer acceptance, resulting in economic losses. Therefore, studies that enable a better understanding of how to use WB meat in the poultry industry are of paramount importance in the current scenario. Different researches have been demonstrated the potential of the WB in the production of meat products such as sausages (Madruga et al. 2019). Thus, the aim of this study was to investigate the effect of WB meat on the texture parameters and acceptability emulsified chicken patties.

Material and methods

Sample selection

Ten kilograms of boneless and skinless breast fillets (normal and WB) were obtained from Cobb® birds (males and females) after they were slaughtered at an age of 42–48 days in a slaughterhouse certified with Federal Inspection Seal (FIS). All other ingredients used in the processing of emulsified chicken patties were purchased in the local market of João Pessoa, Paraíba.

Broilers were slaughtered according to the Brazilian legislation (Brasil 1998), being submitted to electrical stunning, bleeding, scalding, evisceration, chilling and deboning. Breast selection (normal and WB) was manually

performed through palpation of the muscle and verification of the appearance of chicken breast cuts according to procedures described by Bailey et al. (2015) and Kutappan et al. (2013).

After sample collection, the chicken breasts were stored at 4 °C for 24 h and frozen at –18 °C for 2 days until elaboration of emulsified chicken patties.

Processing of emulsified chicken patties

Three formulations of emulsified chicken patties were processed (Table 1): 100% normal breast (PN), 100% wooden breast (PW) and 50%: 50% normal: wooden breast (PNW). Regarding to the processing of emulsified chicken patties, the breast fillets were ground in an industrial grinder (Ibrasmak, MC 160, São Paulo, Brazil) and emulsified in a cutter (G. Paniz, 90,510, Caxias do Sul, Brazil) for 6 min with ingredients and additives (Table 1). Cold water was used to maintain meat emulsion temperature below 12 °C. The meat emulsion (100 g) was molded (10 cm diameter and 1 cm thickness) and wrapped in low-density polyethylene film. Finally, twenty samples per treatment ($n = 20$) of emulsified chicken patties were frozen at –18 °C and stored for further analysis.

Texture measurement

Texture assessment was performed in cooked samples. The samples of each treatment were cooked using an electrical grill (CKSTGR 3007, Oster, China) at 175 °C according to a standard protocol of 3 min, 2 min and then 15 s on each side until an internal end point temperature of 75 °C (El-

Table 1 Emulsified chicken patties formulations elaborated with N chicken breast, WB chicken and their mixture

Raw material (%)	Formulations		
	PN	PW	PNW
Normal meat	70.0	–	35.0
Wooden Breast meat	–	70.0	35.0
Chicken skin	15.0	15.0	15.0
Cold water	15.0	15.0	15.0
Ingredients (g/kg)			
Onion dried	40.0	40.0	40.0
Garlic dried	20.0	20.0	20.0
Sodium Chloride	20.0	20.0	20.0
Cumin	10.0	10.0	10.0
Chili dried	1.00	1.00	1.00
Glutamate monosodium	1.00	1.00	1.00

PN: only normal chicken breast meat; PW: only WB meat; PNW: mixture normal chicken breast meat and WB meat

Magoli et al. 1996). Six cylindrical samples (2.5 cm diameter \times height of 1.0 cm) were taken from random locations in each treatment with a cylindrical cutter. Texture profile analysis (TPA) was carried out using a TA-XT2i Texture Analyzer (Stable Micro Systems, Surrey, United Kingdom) equipped with a cylindrical probe of 3.5 cm diameter (P/35) to compress each sample to 40% of its original height at a cross-head speed of 5 mm/s. Hardness (N), gumminess (N), chewiness (N), springiness (dimensionless), cohesiveness (dimensionless) and resilience (dimensionless) were determined according to Bourne (2002). Warner–Bratzler shear force (N) of cooked chicken patties was measured in eight rectangular blocks (2.5 cm \times 1.0 cm \times 1.0 cm) per treatment using a TA-XT2i Texture Analyzer (Stable Micro Systems, Surrey, United Kingdom) equipped with a Warner–Bratzler rectangular shear blade (10 mm/s test speed). Maximum force to cut the samples was recorded as the shear force.

Microbiological assessment

The microbiological analysis of emulsified chicken patties was carried out according to APHA (2015) in order to assure the sanitary conditions for consumption by the sensory assessors. The reference criteria used was established by Brazilian legislation (Resolution no 12; group 5, item (f), which states that Coliforms at 45 °C/g, *Staphylococcus* coagulase positive/g, reducing sulphite *Clostridium* and *Salmonella* spp./25 g must be analyzed for frozen and chilled meat products (Brasil 2001). Results were calculated as the means of three determinations.

Sensory evaluation

The evaluations were authorized by the Ethics and Research with Human Beings Committee (ERHBC 88553618.2.0000.5183), meeting the ethical and scientific requirements from Resolution number 466, National Health Council (Brasil 2012). Samples of each treatment were cooked using the same conditions described in “Texture measurement” section. Sensory characterization of emulsified chicken patties processed with normal and wooden breast chicken meat was conducted by 100 untrained between recruited among students and faculty members from the Federal University of Paraíba campus who reported regular chicken patties intake. Acceptance and purchase intent tests were carried out according to Meilgaard et al. (1999). Acceptance test assessed color, aroma, flavor, texture, appearance and global impression using a 9-point hedonic scale ranging from 1 (extremely disliked) to 9 (extremely liked). A 5-point hedonic scale was used for the test of intent to purchase. The sensory sessions occurred in individual booths under white

fluorescent light and the samples were randomly served on plastic cups with a glass of water and a piece of unsalted cracker. Acceptability Index (AI) was calculated as follows: $AI = (Ma/9) \times 100$, where Ma is the mean of the evaluated attribute.

Statistical analysis

A one-way ANOVA was applied to evaluate the results from emulsified chicken patties characterization. When significant differences were noted ($P < 0.05$), Tukey’s test were carried out. Data from sensory analysis was treated by a non-parametric Kruskal–Wallis test using SPSS®, version 23.

Results and discussion

All treatments had protein content higher than 15 g/100 g and lipid content lower than 23 g/100 g (data not shown), corroborating limits recommended by the Brazilian legislation for hamburger (Brasil 2000).

Regarding the texture profile of products (Table 2), there was difference among formulations ($P < 0.05$), except for cohesiveness. Hardness, gumminess, and chewiness showed similar behavior between the formulations. PNW treatment displayed a decrease in hardness, gumminess and chewiness variables (58.49%, 60.14% and 58.25%, respectively) compared to PW treatment, while PN sample presented higher values for hardness (32.16 N), gumminess (25.99 N) and chewiness (23.69 N). This result indicates that chicken patties prepared with normal breast need greater force to disintegrate during chewing until it reaches the point of being swallowed. Similar behavior was reported by Rigdon et al. (2020) in chicken sausages formulated with WB. These results suggest that the processing technique used to produce the emulsified chicken patty may be considered as a strategy that can alleviate inferior quality attributes of the raw material since the characteristic harder texture was not observed in the chicken patties formulated with wooden breast (Xing et al 2020). In addition, cooking process also seems to influence hardness and chewiness as noted by Geronimo et al. (2019) in cooked WB.

Regarding elasticity and resilience, the lowest values were obtained for the PN treatment, which indicates that this sample presents lower recovery after removal of the compression force and lower capacity to return to its original state (Bourne 2002).

For all emulsified chicken patties samples, the counts of *Salmonella* sp. (absence) and the global means Coliforms 45 °C ($1.25 \times 10^2 \pm 10.24$ MPN/g), coagulase positive *Staphylococcus* ($1.67 \times 10^3 \pm 0.57 \times 10^3$ CFU/g) and

Table 2 Texture profile of emulsified chicken patties elaborated with N chicken breast, WB chicken and their mixture

Parameter	Formulations			P-value
	PN	PW	PNW	
Hardness ^A	32.16 ± 5.41 ^a	17.91 ± 1.80 ^b	13.35 ± 1.90 ^c	***
Springiness ^B	0.88 ± 0.03 ^b	0.91 ± 0.01 ^a	0.90 ± 0.01 ^{ab}	***
Cohesiveness ^B	0.81 ± 0.01	0.83 ± 0.02	0.83 ± 0.02	ns
Gumminess ^A	25.99 ± 4.64 ^a	14.34 ± 1.25 ^b	10.36 ± 0.72 ^c	***
Chewiness ^A	23.69 ± 4.12 ^a	13.06 ± 1.24 ^b	9.89 ± 1.22 ^c	***
Resilience ^B	0.38 ± 0.01 ^b	0.43 ± 0.03 ^a	0.43 ± 0.02 ^a	**
Shear force ^A	7.11 ± 0.74 ^a	7.56 ± 0.80 ^a	4.89 ± 0.38 ^b	**

PN: only normal chicken breast meat; PW: only WB meat; PNW: mixture normal chicken breast meat and WB meat

^A Data expressed as Newton (N)

^B Dimensionless parameters

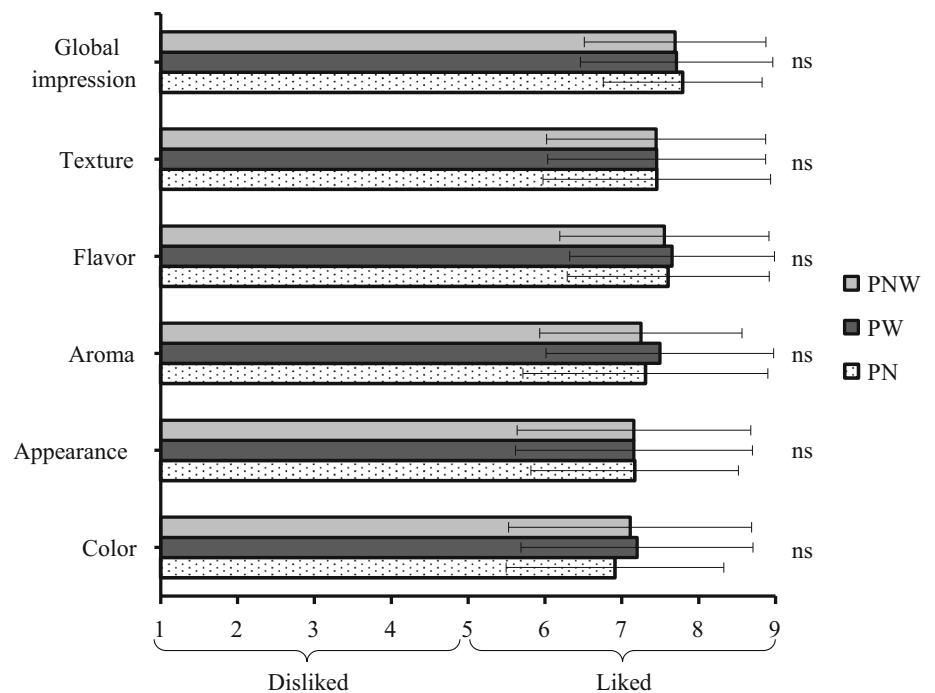
*: $P \leq 0.05$, **: $P \leq 0.01$, ***: $P \leq 0.001$; ns: no significant difference. Different lowercase letters (a, b, c) indicate significant differences among formulations

sulfite-reducing *Clostridium* ($< 1.0 \times 10^2$ CFU/g) were below maximum levels allowed by Brazilian legislation (Brasil 2001). This result indicates that samples were safe for consumption, making possible the sensory evaluation of the product.

The sensory parameters evaluated by untrained judges in the acceptability test did not show significant difference ($P > 0.05$) among samples (Fig. 1), indicating that judges did not perceive any difference in emulsified products formulated with normal and wooden breast. The acceptance index was higher than 70% for all attributes evaluated in the three formulations, which is considered the limit of acceptance, that is, for all treatments, the attributes

evaluated were well accepted among judges, which values were in the scale between “liked slightly” (6) and the “liked very much” (8). These results indicate that it is possible to incorporate meat from wooden breasts into the formulation of emulsified chicken patties without any noticeable sensory alteration. The absence of significant differences between samples processed with normal and wooden breast can be attributed to the technological processes used in the product elaboration such as grinding and emulsification, which alter the structure of the raw material and standardize the characteristics of the final product (Qin 2013).

Fig. 1 Acceptability test of emulsified chicken patties elaborated with normal chicken breast, WB meat and their mixture. Footnote: PN: only normal chicken breast meat; PW: only WB meat; PNW: mixture normal chicken breast meat and WB meat. ns: no significant difference



The purchase intention of products also showed no difference ($P > 0.05$) among treatments. The global mean for PN, PW and PNW treatments was 4.02 ± 1.01 , focusing on the “I would likely buy” scale (4) and suggesting that if processing industries use WB breasts for making hamburgers, potential consumers would buy the product as they would buy those made with normal breast. These results corroborate the data obtained by Qin (2013) when performing the acceptability test on nuggets made with WB and N breasts.

The results of sensorial analysis were compatible with those found in emulsion-type sausages elaborated with normal and wooden breast (Madruza et al 2019). The authors also obtained acceptability higher than 70% for all attributes evaluated and an average score of 3.9 for purchase intention indicating that the sausages elaborated with wooden breast were approved for untrained judges.

Conclusion

In our study, we demonstrated that the wooden breast meat can be effectively used in the emulsified chicken patties formulation without compromising the acceptance of the final product. These achievements may be useful to minimize economic losses and improve production performance in the poultry industry. Further studies may be performed to investigate the effect of different processing techniques on the quality of other meat products prepared with wooden breast meat.

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Data Availability None.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Consent for publication None.

Ethical Approval This study was authorized by the Ethics and Research with Human Beings Committee (CAAE 88553618.2.0000.5183) of the Federal University of Paraíba, João Pessoa, Brazil.

Code Availability None

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