Potravinarstvo, vol. 7, 2013, no. 1, p. 197-201
doi:10.5219/313
Received: 17 October 2013. Accepted: 17 November 2013.
Available online: 19 December 2013 at www.potravinarstvo.com

ISSN 1337-0960 (online)

TEXTURAL PROPERTIES OF CHICKEN BREAST TREATED BY DIFFERENT MEANS

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ABSTRACT

The aim of the study was to compare textural atributes of cooked chicken breast samples subjected to different storage or preparation conditions (raw meat after cooking, raw meat after freezing/subsequent thawing, after storage under modified – controlled conditions) using instrumental analysis. For this purpose, samples were subjected to texture testing by the use of Warner-Bratzler probe, to find changes in muscle hardness by determination of firmness and work of shear. As expected, various values of mentioned atributes were obtained for tested samples treated by three different ways. For statistical evaluation of the results, macro function of Exponent software and paired T test were used, statistically significant differences were taken at p <0.05. In conclussion, different forces were needed for cutting of tested samples, subjected to selected storage conditions, prior to cooking.

Keywords: Chicken breast; texture; HDP/WBV set; firmness; work of shear

INTRODUCTION

Meat, in a broader sense, is constituted of the skeletal muscles together with fat and connective tissues, bones, cartilage, blood and lymph vessels and nerves, obtained during slaughtering of the stock and poultry. In the narrow sense, only muscles without bones, connective tissues, bigger fat layers and vessels are considered as meat **(Kovacevic, 2001)**. Meat quality is defined by the combination of many factors; however, consumers attach a special importance to colour and texture. Inherent characteristics of animal, longand short-term environmental influences on animal and processing parameters that affect the carcass or meat directly are all factors that influence meat colour, texture and flavour **(Lyon et al., 2004)**.

Human perception of meat palatability is derived from a complex interaction of sensory and physical processes during chewing **(Jeremiah, 1982)**. Tenderness or texture is a major quality concern with boneless skinless broiler breast fillets **(Sams, 1999)**. Tenderness has been described as the most important sensory characteristic of meat **(Deatherage, 1963)**. Therefore, this attribute has drawn attention from researchers. Meat texture sensation is dictated by the presence of several factors including the amount of intramuscular fat, water holding capacity and actomyosin complex. However, it is the quality of collagen, which gives toughness to meat **(Coró et al., 2003)**.

Fresh or cooked meat treatments to achieve sensory tenderness are constantly evaluated. For instance, freezing can damage meat definition resulting in textural deficiencies. Other factors such as cooking method, duration of cooking and meat choice extend the range of potential texture-affecting concerns. Because these treatments usually directly affect the muscle fibres, tests that measure some aspects of fibre characteristics are central to research efforts to achieve simple, yet accurate, ways to evaluate the eating quality of meat. Texture is one of the most important attributes noted by consumers when assessing acceptability of cooked meat **(URL 1, 2013)**.

Many methods exist for measuring tenderness of broiler breast meat. Instrumental analyses, descriptive sensory analysis, consumer sensory evaluations, or combinations of these tests have been utilized for assessing tenderness. **Bourne (1982)** reported that instrumental measurements are meaningless unless they correlate well with sensory analysis. Instrumental methods such as Warner–Bratzler Shear Blade and Texture Profile Analysis are commonly used within the poultry industry for evaluating tenderness in broiler breast meat **(Sams et al., 1990)**. There are two factors or benefits to consider when investigating the possible use of a texture analyzer in food. The first benefit consideration is in reference to the manufacturing process itself, process adjustments can be made to control this variability. The second benefit often revolves around raw material supplies. The quality or characteristics of raw materials can often vary between batches or length of storage time. This can affect production and product characteristics **(URL1, 2013)**. The benefits of making objective, accurate, and repeatable physical testing can shorten the product development cycle, improve product consistency, and minimize waste. Texture analysis is a key tool in this way **(URL1, 2013)**. If the first assessment of meat texture characteristics by a consumer is to cut or bite through the fibres, a logical test approach would be to measure the force to cut or break the fibres to provide an indication of what the consumer might perceive. The biting action is used as a basis of many devices designed to provide a measure that will closely relate to human assessment. The most common biting or shearing system for the assessment of meat and meat products is the Warner-Bratzler shear blade. This fixture is an empirical technique and remains as the main reference in parallel with sensory determinations for the assessment of raw or cooked meat. Standard Warner-Bratzler shear force involves measurement of raw or cooked meat tenderness using a Warner-Bratzler blade (Food online). Warner-Bratzler shear force measurements are the most popular indicator for meat texture **(Culioli, 1995)**.

The objective of the present study was to investigate the influence of thermal processes on tenderness and losses of chicken breast meat. Freezing (24 h at -8 °C) and modified – controlled storage were used in the study of textural changes of cooked chicken breasts. For this purpose, texture profile analysis (TPA) of treated samples was performed to determine changes in muscle hardness. In order to achieve this purpose, a series of samples were selected, these cooked in an oven. The weight losses were considered cooking losses, while the variation of tenderness was analyzed by textural measurements.

MATERIAL AND METHODOLOGY

Instrumental equippment

- Conventional freezer: Indesit Prime (Indesit Company, Spain)
- Conventional oven: Mora ES 241 MW (Mora Moravia s.r.o., Czech Republic)
- Thermostatic chamber: Firlabo BVEHF (Fabrilabo, France)
- Texture analyser TA XT2 plus (Stable Microsystems, United Kingdom) equipped with 5kg load cell

Set to texture measure: Warner-Bratzler blade (TA-42) of „European standard" (The blade is 1.2 mm thick with a rectangular hole 11 mm wide and at least 15 mm high. The hole has square smooth edges and the blade is pushed at 50-100 mm/min between side plates positioned to provide a minimum gap between blade and plates). Heavy-duty platform (Stable Micro Systems)

Samples

Commercial Chicken broiler breast were obtained from the slaughtary company immediately after the slaughtering and cutting. Chicken broiler breast was chilled directly in the company to 4 °C and transferred to the laboratory in the portable fridge. We have obtained eighteen chicken breast. The sample was represented with three chicken breast. Samples were analysed immediately or after the storage in defined conditions. Before analysing, samples were cooked.

A Chilled – fresh (4 °C) (analysed immediately after cooking)

B Chilled – fresh (4 °C) (analysed 24 hours after cooking, stored at 4 °C);

C Re-frozen at -18 °C (2 x 6 days);

D Frozen at -18 °C (6 days);

E Chilled – stored (2 days at 22 °C), (cold chain demage simulation);

F Chilled – stored (2 days at 12 °C) (cold chain demage simulation);

Sample preparation.

To measure changes on the muscle fibres in focus to products firmness, commercially supplied chicken breast muscle was subjected to texture analysis in raw stage, after frozen storage, after storage under modified - controlled conditions (48 h, 30 °C, and 60% relative humidity). Chicken breasts in frozen stage were completely thawed at 4 °C overnight. Prior testing, samples were oven-baked to an internal temperature of 74 °C in a conventional oven set at 177 °C for 20 min, and cooled to room temperature (22 °C) for 1 h in storage aluminium foil before measuring in all above mentioned cases of chicken breast samples. The differences in weight of the chicken breast before and after frozen storage, after storage in modified - controlled conditions or cooking were calculated as drip loss or cooking loss, respectively.

Warner-Bratzle shear force measurement

Shear force was measured using a TA.XT2 plus texture analyzer (Stable Micro Systems). The sample was cutted from cooked chicken breast meat and taken to avoid damage. Sample strips have been cutted with a 100 mm^2 (10 mm x 10 mm) crosssection with the fibre direction parallel to a long dimension of at least 30 mm. This weighed amount was enough to approximately fill the shear cell by 50% of its capacity. The sample was sheared at right angles to the fibre axis - across the muscle fibers with a standard knife blade (TA-42) (68 mm wide × 72 mm long × 3 mm thick), to a penetration depth of 20 mm. Three chicken breasts per treatment were sheared (3 x 15 sample strips per group). Three shear force values were recorded for each breast by the use of texture Exponent software 5,0,9,0 (Stable Micro Systems). The parameters measured from the force deformation curve were the peak force (the maximum recorded) and the total shear energy (the area under the force deformation curve from the beginning to the end of the test).

Test Set-Up

The empty shear plate was secured in the heavy-duty platform, which was loosely fixed onto the machine base. The blade was attached to the load cell carrier by means of the rapid locating adapter and lowered slowly into the shear plate and through the base slot. Platform was then manoeuvred until clearance was visible between the blade and slot to avoid frictional effects. The blade was then raised above the plate to allow for placement of the test sample. Before carrying out the test, the blade was calibrated to acknowledge the bottom of the plate as a zero position.

To optimise test settings the first tests were performed on the hardest samples (sample after storage under modified - controlled conditions) to anticipate the maximum testing range required and ensure the force capacity for all tested samples.

Data Analysis

Values of particular interest for sample analysis were automatically obtained by a MACRO (Exponent - Stable Micro Systems software). Results obtained from tested samples gave the total area - area under the curve (Work of Shear) and mean maximum force (Max. Shear Force) values. For more statistical study, the results were tested by the use of paired t-test (Tanagra 1.4.43 software).

RESULTS AND DISCUSSION

Samples of chicken breast after six different storage conditions were subjected to texture analysis on the texture analyzer TA.XT2 Plus (Stable Microsystems). The measurements were performed on the samples after their heat treatment in an electric oven for until the sample has reached the core at 75 °C. The texture analyzer continuously recorded the force, distance and time for the current material deformation pressure in the form of the deformation curve.

Statistical evaluation was performed by Exponent software (Stable microsystems) in focuse to average values calculation and Tanagra software (paired T test) for significant differences identification between individual samples. Chilled chicken breasts - sample A were chosen

Table 1 Average values and standard deviations of tested samples

Sample	Average Shear strength (N)	Standard deviation (N)	Average Work of Shear (N.s^{-1})	Standard deviation (N)
A	10.941	±4.426	60.736	±17.910
B	13.518	±7.412	79.051	±36.301
C	13.728	±5.206	70.179	±23.566
D	11.532	±6.137	59.830	±25.186
E	11.818	±4.817	61.718	±17.666
F	17.191	±8.174	100.646	±37.459

* Considerations for the labeling of samples in tables and figures: **A** Chilled – fresh (4 °C) (analysed immediately after cooking); **B** Chilled – fresh (4 °C) (analysed 24 hours after cooking, stored at 4 °C); **C** Re-frozen at -18 °C (2 x 6 days); **D** Frozen at -18 °C (6 days); **E** Chilled – stored (2 days at 22 °C), (cold chain demage simulation);
F Chilled – stored (2 days at 12 °C) (cold chain demage simulation);

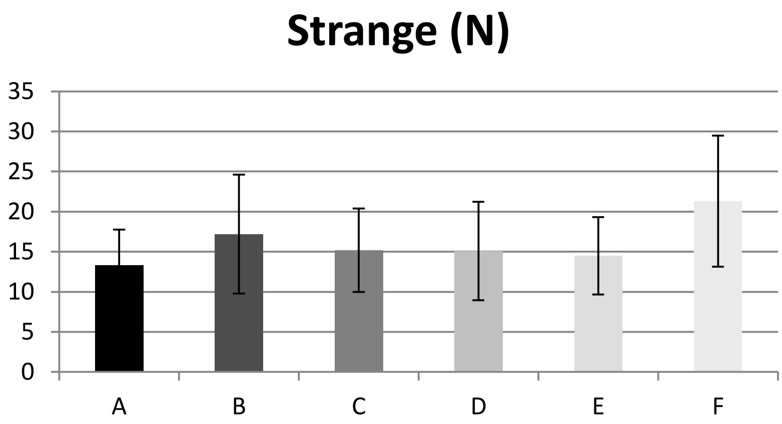

Figure 1 Identified values for strange (N) by individual samples

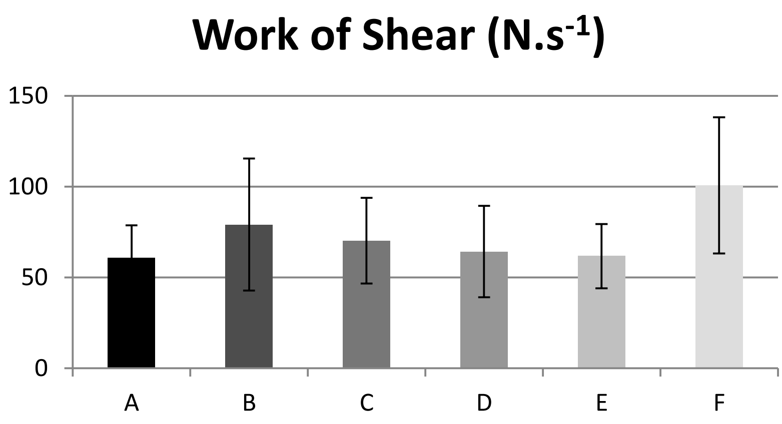

Figure 2 Identified values for work of shear (N.s^{-1}) by individual samples

as the standard, to that were compared all other samples after different storage conditions. Comparison was done in determining parameters, the total strength (N) and work of shear ($N.s^{-1}$). The average values of the individual test samples are listed in Table 1 as well as plotted in Figure 1, and Figure 2.

Sample A (Table 1) has the lowest average value for the strength (10.941 N), on the other hand the highest average strength value has the sample F (17.191 N). In terms of the mean value for the work of shear, the lowest value was found in the sample D (59.830 $N.s^{-1}$) and the highest for a sample F (100.646 $N.s^{-1}$). The storage of already cooked chicken breast for 24 hours – sample B was leading to an increase of the shear work about 19.221 $N.s^{-1}$ versus the samples D. The measured value for sample B was 79.051 $N.s^{-1}$. Repeated freezing of poultry meat causes increasing the force required to cut through a sample of defined dimensions, probably due to decrease in the water content of the sample influenced by damage of the muscle cell by ice crystals. The difference in mean value of shear strength between the sample A and sample C was 2.787 N and in mean value focused to work of shear was 9.443 $N.s^{-1}$. Storage under unfavorable conditions affects the quality of chicken breast. The difference in the average value for shear strength between the samples A and the sample F, was found as 6.25 N and in mean value for work of shear it was 39.91 $N.s^{-1}$ (Table 1). The storage of samples under higher temperatures causes the acceleration of chemical, microbiological and enzymatic changes what results in the changes of muscle fibres textural properties.

From the output of the statistical software program Tanagra was identified significant difference ($p < 0.001$) between the sample A and the sample F for shear strange textural parameter (Table 2). Therefore, we can state that storage at 12 °C two days significantly affecting the strength of chicken breast. Another significant difference ($p < 0.05$) for strength was found between the sample A and the sample B. In the case of work in shear (Table 3), we have identified a significant difference ($p < 0.001$) between the samples A and the sample F. Another significant difference ($p < 0.05$) was identified between the sample A and the sample B.

Textural analysis is mainly used for food businesses to assess products in terms of their balance. The food texture can be measured during/after their manufacture, or after a period of storage of the product. Therefore the evaluation of textural properties brings a fundamental process of evaluation the quality of food products. **Yoon (2002)** in his study focused to the structural and microstructural properties of frozen chicken breast indicates that the method of storage has a significant influence on the final evaluation of the structural properties of the meat. Similarly, **Březina (2003)** argue that lowering the temperature slows the progress of chemical, microbiological and enzymatic changes that have a significant role in the final evaluation of textural properties of the meat. He recommends the storege conditions for fresh meat at temperatures below 5 °C, where the temperature should not fall below -1 °C. According to our results evaluated by statistical software, similar findings have been recorded. The obtained results confirm the assumption, that the cooling and freezing reduces the strength and work of shear during cutting the samples of chicken breast. Improper storage at elevated temperature than recommended leads to denaturation of myofibrillar proteins, what causes hardening of the meat **(Palka a Daun, 1999)**. Similar findings were recorded in the present study.

CONCLUSION

Instrumental analyses of texture properties have become a useful tool in determination of input product quality. Similar studies may point to textural changes of meat of various origins, according to term and method of product storage. Processors and customers in practice may apply recommended storage time or method with minimal negative effect to textural properties in compare to raw product parameters.

We have found, that the average shear strength and average work of shear of the middle area of deboned broiler breast meat fillets are depending on the storage conditions prior the cooking.

The lowest average shear strength 10.941 N was determined in chilled – fresh chicken breast. The highest average shear strength 17.191 N was determined in chicken breast stored at 12 °C two days.

The lowest average work of shear 60.736 $N.s^{-1}$ was determined in chilled – fresh chicken breast. The highest average work of shear 100.646 $N.s^{-1}$ was determined in chicken breast stored at 12 °C two days.

COMPLIANCE WITH ETHICS REQUIREMENTS

This article does not contain any studies with human or animal subjects.

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Acknowledgments:

This work was supported by the VEGA grants from the Ministry of Education Science, Research and Sport of the Slovak Republic, grants No. 1/1074/ 11.

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