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ANALYSIS OF THE COMPONENTS OF COLOUR OF BEEF INSIDE AFTER THERMAL TREATMENT CONDUCTED USING VARIOUS METHODS[1]

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Abstract. In the article, various methods of thermal treatment and their influence on components of colour of beef inside (cut meat and browned surface) are presented and compared. Thermal treatment was conducted to the temperature of 71ºC inside beef inside. Significant differences ($p < 0.01$) were observed between RGB components of colour of beef inside (both cut meat and browned surface) for contact grill, pan frying, roasting and "delta" roasting. All the components of colour were different for "delta" roasting and other methods and for "delta" roasting the lowest values of RGB components of colour were observed for colour of browned surface.

Key words: colour, beef, inside, thermal treatment

Introduction

A factor that affects the quality of beef meals is a selection of a suitable method of thermal treatment for an element. Methods of thermal treatment determine the colour of the final product (Mohammad Nisar et al. 2010). Colour of raw meat and meat after thermal treatment is one of the most important attributes of freshness and quality and determines

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whether it is accepted by consumers (Jo et al. 2000). Having various methods of thermal treatment to choose between: grilling, roasting, frying, cooking etc. the selection of methods must depend on the element subjected to treatment. It happens frequently that this selection is inappropriate and does not emphasise the best meat properties, but it may deepen negative features. Measurement of meat colour allows obtaining information concerning its final quality (García-Segovia et al., 2007).

We have to keep in mind that shaping positive experiences related to particular beef, thus influencing not only consumer's decision on purchase but also consumer's decision on a repeated purchase is important. Therefore, producers should be aware which features will characterize meat during thermal treatment performed by consumers at home (King and Whyte, 2006).

The aim of this paper is to analyse beef colour components at the cross section and browned surface of meat for beef inside subjected to various thermal treatment methods.

Material and methods

The subject of research were samples of beef inside from crossbreading of meat breeds with diary breeds. In this research, meat samples from 20 animals were applied. Elements were cuts from the back half-carcases obtained in the abbatoir. After vacuum packing they were transported (with maintaining cold chain) to the laboratory in WULS-SGGW in Warsaw. Slices of 2.5 cm thickness were collected from each element.

Meat slices were subjected to thermal treatment with four methods: traditional roasting method, "delta" roasting ("delta" roasting is roasting at constant difference in temperature between the sample inside and a heating medium), pan frying and grilling. Treatment was maintained to temperature 71ºC inside the meat slice. Temperature of 71ºC inside meat (in the geometrical centre of the tested meat sample) is recommended to consumers as a final temperature of the thermal treatment process (USDA, 1993). Then, analysis of the muscle tissue colour at the cross section was carried out (parallely to the slice surface) and the samples surface according to the accepted method of computer analysis of the image with the use of ImageProPlus 7.0 (Media Cybernetics) software. Pictures were taken with the use of digital camera (QImaging, Micro Publisher 5.0 RTV) at fluorescent lamps lighting (Osram Dulux L 36W/954, light colour daily, light stream 2350 lm) of colour temperature 5400K similar to solar light. Measurement system was previously calibrated towards white standard. For all samples, values of particular pixels were collected, values of mean and standard deviation for the analysed surfaces were calculated.

Statistical analysis was carried out with the use of Shapiro-Wilk test and t-Student test (hypothesis test). In order to determine statistical significance the level of $p \leq 0.05$ was assumed. Moreover, significance at the level of $p \leq 0.01$ and $p \leq 0.001$ was indicated. Statistical analysis was carried out with the use of Statistica 8.0 (StatSoft Inc) software.

Results and discussion

Figure 1 presents the obtained measurement results of the colour components, in the RGB system, of the beef inside at the cross-section of meat subjected to thermal treatment

(grilling, roasting in the convectional-steam oven, "delta" roasting, pan frying). For the analysed thermal treatmant techniques, some differences were reported, particularly with reference to R component, which was presented in table 1. In previous research of Guzek et al. (2013) it was also reported that for colour component R, statistically significant impact of the researched surface (p=0.0000) was reported independently from the applied thermal treatment technique.

Table 1.
Comparison of particular colour components of meat at the cross section for samples of beef inside subjected to thermal treatment carried out with the use of various thermal treatment techniques

Comparison of thermal treatment techniques	p-Value for colour components		
	R	G	B
Grilling vs. "delta" roasting	0.0000***	0.0008***	0.0000***
Grilling vs. roasting	0.0369*	ns	ns
Grilling vs. pan frying	ns	ns	ns
"Delta" roasting vs. roasting	0.0119*	0.0151*	0.0087**
"Delta" roasting vs. pan frying	0.0012**	0.0031**	0.0046**
Roasting vs. pan frying	ns	ns	ns

ns – no statistically significant dependence (p>0.05), * p≤0.05, ** p≤0.01, *** p≤0.001

It is commonly known that various techniques of thermal treatment, considerably affect physical properties of meat and consequently its final quality (Combes et al. 2003) whereas research are not always conducted with treatment carried out to the same temperature inside meat sample, which would allow comparison of the process impact, which was emphasised in case of the performed research.

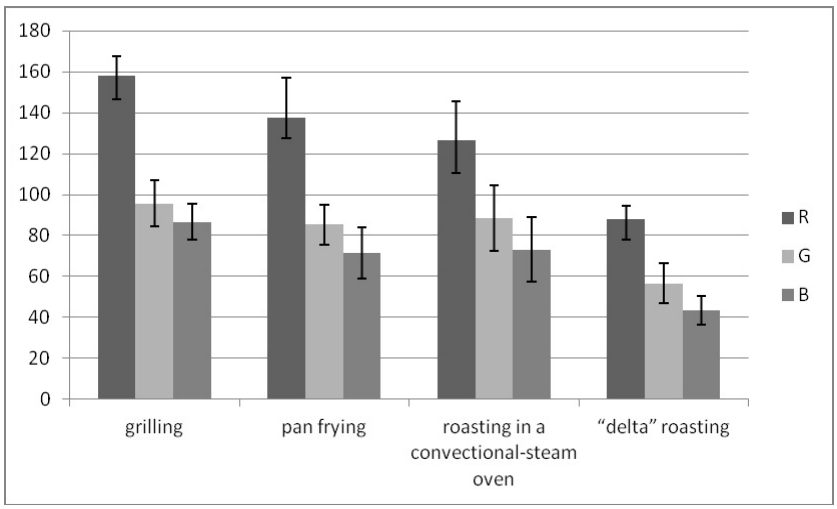

Figure 1. Colour components of beef inside subjected to thermal treatment measured in the RGB system

It was reported that all colour components differed between the samples subjected to "delta" roasting and those subjected to treatments with the use of the other techniques – for "delta" roasting all colour components were the lowest. Moreover, for the R colour component differences were reported between samples subjected to grilling and those subjected to roasting , which were characterised with lower values of this component. These results are in accordance with the research of other authors, who studied the impact of the applied thermal treatments on changes of colour parameters and general appearance of buffalo meat (Mohammad Nisar et al., 2010).

Figure 2 presents the obtained measurement results of the colour components in the RGB system of browned surface of beef inside colour subjected to thermal treatment (grilling, roasting in the convectional-steam oven, "delta" roasting, pan frying).

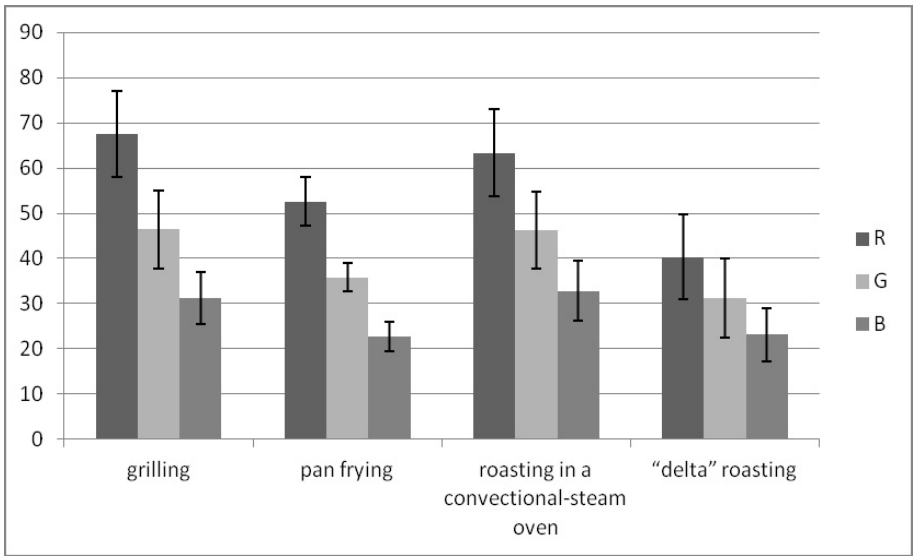

Figure 2. Colour components of browned surface of beef inside subjected to thermal treatment measured in RGB system

Moreover in this case differences in the colour components concerned mainly R component, which was presented in table 2.

Differences of colour components R and G were reported between samples subjected to "delta" roasting and those grilled and roasted in a convectional-steam oven. Moreover, differences in R and B components were reported between the fried and grilled samples and for B components also – between those subjected to pan frying and roasted. Similarly, as in case of analysis of meat colour at the cross section, also in this case, the lowest values of components were reported for "delta" roasting.

The thermal treatment process itself is subjected to the impact of three factors – meat surface temperature, temperature profile inside meat and the thermal penetration manner (Panea et al., 2008). Temperature gradient in meat influences the speed and degree of

protein structure changes and thus the properties perceived by a consumer (Bejerholm and Aaslyng, 2003) which is of significance in case of the use of thermal treatment in an oven with "delta" method – with the maintenance of the constant difference in temperature between the sample inside and a heating medium. These differences are visible in the presented results.

Table 2.
Comparison of particular colour components of browned surface of meat for samples of beef inside subjected to thermal treatment carried out with the use of various treatment techniques

Comparison of thermal treatment techniques	p-Value for colour components		
	R	G	B
Grilling vs. "delta" roasting	0.0036**	0.0396*	ns
Grilling vs. roasting	ns	ns	ns
Grilling vs. pan frying	0.0254*	ns	0.0319*
"Delta" roasting vs. roasting	0.0093**	0.0400*	ns
"Delta" roasting vs. pan frying	ns	ns	ns
Roasting vs. pan frying	ns	ns	0.0243*

ns – no statistically significant dependence ($p>0.05$), * $p\leq0.05$, ** $p\leq0.01$

Table 3 presents comparison of particular colour components of meat at the cross section and browned surface for samples of beef inside subjected to thermal treatment carried out with the use of various thermal treatment techniques.

Table 3.
Comparison of particular colour components of meat at the cross section and browned surface for samples of beef inside subjected to thermal treatment carried out with the use of various thermal treatment techniques

Comparison of thermal processing techniques	p-Value for colour components		
	R	G	B
Grilling	0.0000***	0.0001***	0.0000***
"Delta" roasting	0.0000***	0.0047**	0.0022**
Roasting	0.0009***	0.0030**	0.0015**
Pan frying	0.0000***	0.0000***	0.0001***

** $p\leq0.01$, *** $p\leq0.001$

For all applied treatment techniques all researched colour components differed significantly. However, for various treatment techniques different level of significance of the mentioned difference was reported. The strongest differences of the values of colour components of the browned surface ($p<0.001$) were reported for samples subjected to grilling and pan frying which proves significant browning of the samples surface resulting from the contact treatment technique. Moreover, equally strong differences were reported for all

thermal treatment techniques in case of R colour component. Thermal processes which take place with the contact with heating sufface allow production of Maillard's reaction products, which influence characteristic taste of meat (Raj et al., 2005) which has place in case of pan frying and grilling. In case of roasting, surface treatment is not so intense, therefore the profile of a product obtained in this way does not differ.

Conclusions

1. For beef inside samples, subjected to thermal treatment in the convectional-steam oven, with the use of "delta" method , the lowest values of colour components of meat at the cross section, measured in the RGB system were reported in comparison to traditional roasting, grilling and pan frying.
2. For the browned surface of beef inside the lowest values of R and G colour components were reported in case of thermal treatment in the oven with the use of "delta" method in comparison to those grilled and roasted in the convectional-steam oven.
3. For all used thermal treatment techniques, all colour components of beef inside differed significantly at the cross section and its browned surface, however, the most significant differences were reported in case of pan frying and grilling.

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ANALIZA SKŁADOWYCH BARWY ZRAZOWEJ WOŁOWEJ, PODDANEJ OBRÓBCE CIEPLNEJ PROWADZONEJ RÓŻNYMI TECHNIKAMI

Streszczenie. Oceniono wpływ różnych metod obróbki cieplnej zrazowej wołowej, na zmiany składowych barwy zarówno na przekroju, jak i zbrązowionej powierzchni mięsa. Między poszczególnymi zastosowanymi technikami obróbki cieplnej, w zakresie składowych barwy na przekroju próby, jak i zbrązowionej powierzchni mięsa, mierzonej w systemie RGB, stwierdzono statystycznie istotne różnice ($p < 0,01$). Zauważono, że wszystkie składowe barwy mięsa na powierzchni przekroju plastra różniły się między próbami poddanymi pieczeniu typu „delta", w porównaniu do poddanych obróbce pozostałymi technikami oraz, że próby pieczone w piecu konwekcyjno-parowym cechowały się najmniejszymi wartościami składowych dla barwy powierzchni przekroju plastrów wykrojonych z wołowej górnej zrazowej poddanych zróżnicowanej obróbce cieplnej.

Słowa kluczowe: barwa, mięso wołowe, zrazowa górna, obróbka cieplna

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