...YGENATION OF RARE AND MEDIUM ROASTED NORMAL AND DFD BEEF

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...colour of rare (T_i= 50°C) and medium (T_i= 65°C) roasted m. longissimus dorsi (LD) of normal and DFD ...ity of young bulls after aging (10 days at 2°C) was investigated with instrumental (Minolta CR 200-b ...ometer, FOP apparatus) and sensory analysis, before and after oxyenation (at -5°C, 30'). The depht and ... of oxygenated layer and pH of meat were also measured.

...r oxygenation b-value of rare and medium roasted normal and DFD meat always increases ($p \leq 0,001$). More- ... a-value for colour of rare roasted normal and DFD samples increases ($p \leq 0,01$). Only rare-roasted normal ... shows optimal oxygenated bright red colour.

...depht and area of oxygenated layer in roasted DFD meat are brigher than in roasted normal meat (differ- ...s are nonsignificant). FOP-values at roasted DFD meat are significantly ($p \leq 0,001$) lower than at normal ... This results for DFD samples are probably consequence of the relation T_i/pH (50°C/6,6), which inhibits ...globine denaturation.

...ODUCTION

...n (oxygenation) is the development of a bright red colour when meat is exposed to air, due to the oxyge- ...on of myoglobin to form oxymyoglobin as the predominant surface pigment (Egbert and Cornforth, 1986). ... cutting beef is characterized by a high postmortem pH and the fact that it will not bloom when exposed ...air. The high pH of dark cutting beef is only indirectly related to colour. The dark colour is more ...tly related to high mitochondrial respiration, which keeps oxymyoglobin concentration low and Lawrie ...) concluded that increased oxygen comsumption of dark cutting meat could increase the concentration of ...genated myoglobin, thus resulting in dark colour. Egbert and Cornforth (1986) found that dark cutting ... muscle will turn red if mitochondrial respiration is inhibited, allowing myoglobin at muscle surfaces ...main oxygenated.

...ate heating of the myoglobin, oxymyoglobin and metmyoglobin pigments in normal (pH 5,3 - 5,7) fresh ...le produced globin ferrihemochrome, the grey pigment of cooked meat (Fox, 1966). Red to pink colour in ...h cooked meat has been attributed to several factors. Although the cause of this problem has not been ...rmined, a few possibilities exist: (1) the myoglobin has been converted to a pink hemochrome during ...ing, (2) the myoglobin has not been completely denatured (Trout, 1989), (3) nitric oxide (Braut, 1984), ...stress (Babji et al., 1982) and the formation of a reduced nicotin amide-denatured globin hemochrome ...ng cooking (Cornforth et al., 1986). Red to pink colour in fresh cooked meat may also be due to incom- ...e denaturation of myoglobin during cooking. It depends on the degree of doneness. The lack of brown ...ked colour was most visible in meat with the highest concentration of myoglobin (Mendenhall, 1989). A ...dy showed that, even when cooked to the same internal temperature high-pH beef (pH>6,0) was redder than ...pH-muscle (pH 5,5) and appeared undercooked (Schmidt and Trout, 1984). The explanation suggested for ...s behavior was that high pH reduced the amount of myoglobin denatured at a given temperature. Only this ...fully explain the nature of the problem.

...objective of this study was to treat dark cutting and normal beef with heat to the different degrees of ...oness and chilling of slices of roasted-beef at low temperature (-5 to -10°), in an attempt to inhibit ...reduce mitochondrial respiration and thereby obtain bloom in roasted beef.

...RIAL AND METHODS

... beef LD were obtained 24 - 48 h postmortem from commercially slaughtered market animals. Eight samples ...from 7 thoracic to 1 lumbal vertebrae) were taken from two groups with normal and DFD quality for pH ...surement to enssure that the pH of each muscle was normal (< 5,9) or higher (>6,2).

...ples were vacuum packaged and stored (aged) in a refrigerator. After ageing (10 days at 2°C) LD were cut ...to two pieces; cranial pieces were cooked (roasted) to an internal teperature of +50°C (rare roasted) and ...dal pieces to +65°C (medium roasted). Internal temperature of samples was monitored using termomether ...ab placed in the geometric center of samples. Prepared samples were cooled in a refrigerator at 0 - 2°C ...r 3 days until analysed.

... colour of rare and medium roasted LD of normal and DFD quality of young bulls was investigated by in- ...rumental and sensory methods, before and after oxygenation (2 cm slices were taken from each groups in a ...ezer at -5 to -10°C for 30 minutes). The depht and area of oxygenated layer and pH were also measured. ... colour was instrumentally analysed by Minolta CR 200 B chromomether and FOP apparatus. Minolta reading ...e included measurement L- (lightness), a- (redness) and b- (yellowness) values. The translucence was ...sured by FOP apparatus.

All treated samples were submitted to sensory analyses. The surface colour of the slices (2 cm) was determined using a 4 member trained sensory panel. Panel members were instructed to rate each sample on a scale of 1 to 7 (1=yellowbrown 4=bloom, brightred 7=purple).

RESULTS AND DISCUSSION

After exposing the surface slices of rare roasted as also medium roasted beef the surface becomes in larger or minor extent and the depht bright red. This is the consequence of the influence of oxygen on myoglobin where bright red oxymioglobin is formed. Oxygenation respectl. blooming of slices is reflected in the increase of two values measured by the Minolta chromometer. Average a-values which define the red colour are significantly increased ($p \leq 0,05$ at normal respectl. $p \leq 0,001$ at DFD quality) only at rare roasted slices (table 1). The highest increase ($p \leq 0,001$) can be identified at b-value which defines the yellow colour at all slices of rare and medium roasted degree of doneness and both qualities. The results of this investigation correspond to the statements of Frohlich (1990) who affirms that after oxygenation of raw beef the a-values increase up to 100%.

Interesting is the fact that only slices of rare roasted beef after oxygenation show sensory evaluated optimal bright red colour (3,91 scores) which is not a consequence of only the oxygenation but also the degree of roasting and a high pH of muscular tissue.

There are no significant differences in the sensory colour of the slices's surface between raw and medium roasted samples of normal and DFD quality (table 2). Even more, from the small difference in the evaluation of colour of rare and medium roasted slices of normal quality it can be resumed that the colour of these two samples is quite similar. Significant is the difference in the colour of raw and medium roasted beef slices of DFD quality. By instrumental measurement a similar statement was achieved: differences between normal and DFD quality of roased beef are well evident ($p \leq 0,01$) only after oxygenation.

After roasting and oxygenation of slices of roasted beef a fallenbehind red colour in a different extent is obvious which extra accelerates coolness. The conclusion from this is that the roasted DFD beef is oxygenated. On slices of roasted DFD beef the measured depht and extent of oxygenation are not sifnificant (tables 3 and 4). On raw roasted beef of normal quality less red colour was measured as on DFD beef. Myoglobin denaturates only during a longer period of heating at 60°C. The combination T_i/pH at normal beef is 50/5,8, at DFD beef 50/6,6. This relation affects the myoglobin in such a way that during heat treatment it denaturates at normal beef in a higher extent as at DFD beef.

At medium roasted samples the depth oxygenation and area of the red colour are smaller as at rare roasted while the quality of muscular tissue had no influence on the depth of oxygenation and extent of red colour.

Other data from instrumantal measurements are also similar and are the consequence of smaller and smaller differences in the microstructure of medium roasted normal and DFD beef.

The absolute depth of the oxygenated layer and the area of red colour depend also on other factors which were not investigated in our research, i.e. activities of respiratory enzymes, quantities of nondenaturate myoglobin, hight of pH and maturity of the muscules, time and temperature of exposure of slices to the effects of oxygen (conditions at oxygenation of slices).

Heat denaturation and coagulation cause on muscle proteins such changes that the microstructure becomes much more open as are the semi-open and closed microstructure of rare normal and DFD beef meat. If we come close to the activities different kinds of acidity of the meat during the heat treatement it can be affirmed that after heating to the same degree of doneness the microstructure od DFD beef remains more open than the microstructure of normal beef as at roasted meat of normal quality the microstructure after heating is more closed because of larger denaturation. High pH at roasted DFD beef partly inhibits denaturation of protein respectl. myoglobin at the same temperature. Smaller mass loss during roasting of DFD beef and measurements FOP values (tables 5 and 6) prove that the process of denaturation at the same internal temperature is more extensive at normal muscular tissue as at DFD.

Statistically FOP values are significantly lower at raw roasted DFD as at normal beef. Differences in FOP values were measured in the center and on the edges of raw roasted beef. Lower FOP values are in the center as there the denaturation is smaller than at the edges.

CONCLUSIONS

This is the demonstration that roasted beef will bloom under appropriate conditions. Mitochondrial inhibition by heating at first and latter by chilling increased the redness of roasted dark cutting and normal beef. Heating would inhibit mitochondrial respiration and allow nondenaturate myoglobin to remain oxygenated.

The combination T_i/pH at normal beef is 50/5,8, at DFD beef 50/6,6. This interaction affects the myoglobin in such a way that it is denaturated at normal beef in a larger extent than at DFD beef. As myoglobin denaturates only during longer heating at 60°C (Tumerman, 1974) almost identical results of measurements are achieved in spite of a different relation T_i/pH at medium roasted beef which is the consequence of smaller and smaller differences in the microstructure after heating of normal and DFD beef.

e 1. Instrumental values (Minolta) and sensory colour evaluation of the surface of raw and medium roasted beef before and after oxygenation

ity	normal			DFD		
roperty	FC $\bar{x}$	OC $\bar{x}$	t-value	FC $\bar{x}$	OC $\bar{x}$	t-value
°C						
value	51,39	50,74	0,26	52,09	51,21	0,35
value	26,60	33,37	-2.75*	22,59	30,29	-4,34***
value	9,69	17,28	-5,22***	7,51	15,35	-5,41***
face colour	4,68	3,39	3,78**	4,59	3,91	1,60
°C						
value	54,11	54,30	-0,09	57,26	57,00	0,13
value	24,42	24,64	-0,13	21,31	23,82	-1,48
value	9,86	13,34	-3,13**	8,98	13,12	-4,44***
face colour	3,67	2,92	1,57	3,53	3,27	0,78

* p≤0,05
** p≤0,01
*** p≤0,001

FC - fresh cut
OC - oxygenated cut

e 2. Instrumental values and sensory evaluation before and after oxygenation of beef of normal and DFD quality roasted up to two T_i.

ity	before oxygenation			after oxygenation		
property	T_i=50°C	T_i=65°C	t-value	T_i=50°C	T_i=65°C	t-value
al						
value	51,39	54,11	-1,17	50,74	54,30	-1,57
value	26,60	24,42	1,01	33,37	24,64	3,40**
value	9,69	9,86	-0,16	17,28	13,34	2,69**
face colour	4,68	3,67	1,96	3,39	2,95	1,69
value	50,09	57,26	-2,07*	51,21	57,00	-2,81**
value	22,59	21,31	0,78	30,29	23,82	3,48**
value	7,51	8,98	-1,16	15,35	13,12	1,92*
face colour	4,59	3,53	2,36*	3,91	3,27	2,11*

* p≤0,05
** p≤0,01

ble 3. Depth of the oxygenated layer on a beef slice of two qualities prepared to two T_i.

ality	treatment T_i=50°C $\bar{x}$	T_i=65°C $\bar{x}$	t-value
mal	1,44	0,80	2,22*
	1,56	0,96	3,10*
value	-0,60	-0,58	

p≤0,05

ble 4. Area of oxygenated layer measured on beef slices of two qualities prepared to two T_i.

quality	treatment T_i=50°C $\bar{x}$	T_i=65°C $\bar{x}$	t-value
normal	67,00	52,41	1,38
DFD	70,52	52,82	3,66**
t-value	-0,41	-0,05	

** p≤0,01

ble 5. FOP values measured in the center of a beef slice of two qualities prepared to two T_i

ality	treatment T_i=50°C $\bar{x}$	T_i=65°C $\bar{x}$	t-value
mal	136,88	145,50	-1,20
	121,69	146,00	-4,34***
value	1,92	-0,11	

p≤0,001

Table 6. FOP values measured on the edges (2 cm left respectl. right from the center) of a beef slice of two qualities prepared to two T_i

quality	treatment T_i=50°C $\bar{x}$	T_i=65°C $\bar{x}$	t-value
normal	139,56	152,56	-2,32
DFD	130,43	147,13	-2,27
t-value	1,26	0,95	

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