Evaluation of prerigor beef burger 2. Effects of acidification and freezing rate

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SUMMARY

The study was conducted to evaluate the combined effects of rigor state, acidification and freezing rate on quality attributes of beef burger. Prerigor beef round muscles were excised from four beef carcasses within two hours from Exsanguination. The treatments included hot processed burger, acidified hot processed burger, using 1% citric acid solution and 48 hours post rigor beef burger. The treatment samples were stored at —18°C for 7 days after being frozen at two different rates —18°C (slow) and — 40°C (fast). The measurements included pH, cooking loss, water index, moisture content, colour and sensory evaluation. The results indicate that the acidified prerigor beef gave burger as tender as the 48 hrs post rigor beef, and was the most juicy irrespective of the freezing temperature. The burgers prepared from the prerigor beef were the lowest in tenderness, juiciness and yield, and were not significantly affected by the freezing rate. Generally, freezing at — 40 °C improved the colour of the burgers in all the treatments. The acidified prerigor beef was equivalent to the 48 hrs post rigor beef burger in water index and had the highest moisture content when frozen at — 40°C . The results demonstrate that quality attributes of prerigor beef burger could be improved by acidification and fast freezing.

INTRODUCTION

Local meat processors working on beef burgers manufactured from prerigor beef have complaints related to toughness and shrinkage of burger on cooking.

Based on the results of previous experiments Mansour, S.F. and Abugroun, H.A. (2001), this research was conducted to evaluate the factors affecting quality parameters of prerigor beef burgers, mainly the effects of freezing rate on quality of beef burger.

MATERIALS AND METHODS

This experiment was designed to evaluate the effects of freezing rate on palatability attributes of beef burger. The beef samples were excised from the beef carcasses at 2 hours post mortem (prerigor meat) and at 48 hours post mortem (post rigor meat, control).

Meat treatments

Muscle samples and treatments were prepared as previously explained Mansour, S.F. and Abugroun, H.A. (2001).

The prerigor beef round muscles were divided into:

1/ Hot processed burger.

2/ Acidified hot processed burger.

3/ The 48 hours post rigor beef (control).

Burger preparation

Burger formulation and preparation were performed as previously explained Mansour, S.F. and Abugroun, H.A. (2001).

Freezing rate and storage

Two Freezing temperatures were used:

-18°C and – 40°C (air blast freezing) as slow and fast Freezing rates respectively. Burgers of each treatment were packaged, labeled and divided into two parts : one was frozen at -18°C and left stored at this temperature until the completion of 7 days. The other part was frozen at – 40°C (air blast freezer) for 24 hours and then transferred to -18°C freezer to complete 7 days. Accordingly, all the treatment samples were stored for 7 days from the time of the slaughter of the animal to simulate marketing conditions in Khartoum.

After the storage period, the treatments were evaluated. The measurements that included pH, cooking loss, colour, water index and sensory evaluation (Tenderness, juiciness, flavour, colour and overall acceptability) were performed as previously explained Mansour, S.F. and Abugroun, H.A. (2001).

Moisture determination

Moisture determination was based on weight loss of 2.5gm samples dried overnight in a drying oven at 120°C and moisture loss was calculated as percentage of fresh sample weight.

Statistical analysis

Statistical analysis were performed as previously explained Mansour, S.F. and Abugroun, H.A. (2001).

RESULTS

The results indicate that, there was a significant difference in tenderness among the treatments ($P< 0.05$; table 1). The acidified prerigor beef gave burger as tender as the burger prepared from the 48 hrs post rigor beef, irrespective of the freezing temperature ($P> 0.05$; table 1). The prerigor beef burger, regardless of the freezing temperature, had the lowest tenderness scores among the treatments ($P< 0.05$; table 1). As for juiciness, the scores followed a trend similar to that for tenderness. In fact, the results indicate that, in all the treatments, the burgers frozen at – 40°C gave better scores in tenderness and juiciness compared with that frozen at -18°C, but the difference was not significant ($P> 0.05$; table 1). The results show that, the flavour and colour were not significantly affected by the various treatments ($P> 0.05$; table 1). Nevertheless,

freezing at – 40°C improved the colour of the burgers in all the treatments compared with the freezing at -18°C, but it was not significant (P> 0.05; table 1).

As for moisture, cooking reduced moisture content in all the treatments (table 2). The burgers prepared from the acidified prerigor beef frozen at – 40°C had the highest moisture content, while the burgers prepared from the prerigor beef and frozen at -18°C had the lowest moisture content (P< 0.05; table 2). Generally, freezing at – 40°C improved juiciness in all the treatments but not at a significant level (P> 0.05; table 2).

Table 1. Means and Standard errors for quality attributes of beef burger from different treatments *

Beef burger treatments

Independent Prerigor beef Acidified 48 hrs post S.E.

Variables prerigor beef rigor beef

	Frozen frozen at at	frozen frozen at at	frozen at	frozen at			
	-18°C	-40°C	-18°C	-40°C	-18°C	-40°C	
Tenderness	5 63[a]	5.60[a]	6.35[b]	6.43[b]	6.13[b]	6.20[b]	±0.1
Juiciness	5.48[2]	5.58[a]	6.23[b]	6.35[b]	5.90[b]	6.08[b]	±0.1
Flavour	5.93′	6.13[a]	6.35[2]	6.10′	6.08[2]	6.13[2]	±0.1
Colour	4.95′	5.13[a]	6.03′	5.38[2]	5.05[a]	5.35′	±0.2

[ab] **:** Means in the same row bearing different superscripts are significantly different (P< 0.05).

* 7 point scale was used by the taste panel where 1 = extremely dislike, 7 = extremely desire.

As for cooking loss (shrinkage %), the burgers prepared from the prerigor beef resulted in significantly higher cooking loss compared with the other treatments, and the loss of that frozen at -18°C was significantly higher than that frozen at -40°C (P< 0.05; table 2). The acidified prerigor beef burger whether frozen at -18°C or at -40°C and the 48 hrs rigor beef burger frozen at -18°C had relatively low cooking losses that were not significantly different (P> 0.05; table 2). The 48 hrs post rigor beef burger frozen at -40°C had the lowest cooking loss among all the treatments (P< 0.05; table 2). The results also show that, in all the treatments, the burgers frozen at -40°C gave lower scores in cooking loss compared with that frozen at -18°C, but the difference was not significant (P> 0.05; table 2). With regard to water index, the results were significantly different among the treatments (P< 0.05; table 2). The results show that, the burgers prepared from the acidified prerigor beef and the 48 hrs post rigor beef (control) frozen at -40°C were not significantly different in water index (P> 0.05; table 2), and gave the highest values compared with the rest of the treatments

(P< 0.05; table 2). The burgers prepared from the prerigor beef frozen at -18°C had the lowest value in water index compared with the other treatments (P< 0.05; table 2). On the other hand, the burgers prepared from the acidified prerigor beef and frozen at -40°C gave the highest value (P< 0.05; table 2). The results also show that freezing at -40°C significantly improved water index in prerigor state. However, the improvement in the post rigor state was also indicated but not at a significant level (P> 0.05; table 2).

Table 2. Means and Standard errors for moisture %, cooking loss (%) and water index from different treatments .

Beef burger treatments

Independent Prerigor beef Acidified 48 hrs post S.E.

Variables prerigor beef rigor beef

Frozen frozen at at -18°C -40°C	frozen at 18°C	frozen at -40°C	froien at -18°C	frozen at -40°C	
Moisture % 32.5a $^{34.43}$ab $^{37.33}$ab $^{39.45}$b $^{35.88}$ab 37.73ab before cooking	±1.4				
Moisture % 22.65^{a} 24.08a	$^{25.95bc}$	27 75b`	$^{26.55}$bc	27.33bc	±0.5
After cooking					
Cooking loss 20.49^{a} 18.00^{b}	16.21′	14.94`	15.49′	12.35^{d}	±0.6
(Shrinkage %)					
Water index 14.25^{a} 18.25^{b}	22.25′	26.95^{d}	20.75^{k}	23.75″	±1.1

abcd

: Means in the same row bearing different superscripts are significantly different (P< 0.05).

Table 3. Means and Standard errors for colour of beef burgers from different treatments .

Beef burger treatments

Independent Variables	Prerigor beef Frozen at 18°C	frozen at -40°C	Acidified prerigor beef frozen at 18°C	frozen at -40°C	48 hrs post frozen at -18°C	frozen at -40°C	S.E. rigor beef	-
Lightness (L)	31.12[a]		30.70[a]		30.55′	32.53[a]	28.55[a]	30.9[a] ±1.7
Redness (a)	11.08[b]		11.08[b]		10.70[b]	10.68[b]	10.60[b]	10.38[b] ±0.5
Yellowness (b)	5.33′		5.25′		4.90`	5.20′	5.00′	4.85′ ±0.3

abc

: Means in the same row bearing similar superscripts are not significantly different (P> 0.05).

Table 4. Means and Standard errors for pH of beef burgers Processed from different treatments .

Beef burger treatments

Independent Variables	Prerigor beef Frozen at 18°C	frozen at -40°C	Acidified prerigor beef frozen at 18°C	frozen at -40°C	48 hrs post frozen at 40°C	frozen at	S.E. rigor beef at -18°C	-
After processing	6.13[a]		6.13[a]		5.43[th]	5.43[th]	5.50[th]	5.50[th] ±0.07
Before cooking	5.94[a]		6.00[a]		5.33′	5.40[th]	5.40[th]	5.50[th] ±0.07
After cooking	5.95′		6.10[a]		5.48[th]	5.53[th]	5.58[th]	5.88[b] ±0.07

abc

: Means bearing similar superscripts are not significantly different (P> 0.05).

Mean values for lightness (L), Redness (a) and Yellowness (b), as objectively determined, indicate that there were no significant differences among the treatments (P> 0.05; table 3). Generally, freezing at —40 °C increased the lightness values in the acidified prerigor beef and in the 48 hrs post rigor beef treatments, but the improvement was not at a significant level (P> 0.05; table 3).

As for pH, the prerigor beef burger at different processing times, whether frozen at —18°C or at —40°C, resulted in significantly higher pH values compared with the other treatments (P< 0.05; table 4). Regardless of the freezing temperature, the 48 hrs post rigor beef (the control), and the acidified prerigor beef burger after processing time, before cooking and after cooking had lower pH values that were not significantly different (P> 0.05; table 4). As indicated in the results (table 4), the cooking process increased the pH values in all the treatments.

DISCUSSION

During fast freezing numerous small ice crystals tend to form uniformly through out all of the meat tissues, so drip losses during thawing are lower compared with the thawing of slowly frozen meat and the product is more juicy. In addition, muscle fiber shrinkage and distortion effects are minimized (Judge *et al.,* 1990).

The slow freezing process causes changes such as protein insolubilization and decrease in elasticity of the thawed tissue. The large extracellular ice crystals formed are easily lost as drip during thawing and the product appears less juicy. Also, as a result of the formation of large ice masses concomitent shrinkage of muscle fiber occurs and this would loose water to extracellular pools (Judge *et al.,* 1990).

Lawrie (1979) showed that freezing makes post rigor meat more tender when the rate is fast enough to cause intrafibrillar ice formation. Freezing at -40°C improved the colour of the burger products in all the treatments compared with freezing at -18°C . The flavour and colour were not affected because all the treatments were similar in ingredients, processing procedures, storage conditions and cooking methods. Improvement in the colour of the burgers frozen at -40°C, which is not detected significantly, could be due to the formation of the numerous small ice crystals throughout the meat tissues, (Judge *et al.,* 1990).

During slow freezing very large extracellular ice crystals are formed, thus distorting and damaging muscle fibers. Moreover, the high ionic strength denatures some of the muscle proteins (Lawrie, 1979). This decreased water-holding capacity resulted in a higher cooking loss. Judge *'et al.,* (1990) showed that, juiciness varies inversely with cooking loss so, the burgers that gave lower cooking losses were higher in juiciness. Thus, the burger of the different treatments frozen at -40°C, gave the highest valties of juiciness compared with that frozen at -18°C due to differences in drip losses.

As for moisture content, cooking reduced moisture content in all the treatments. The shrinkage of tissue and the release of juice are caused by changes in the fibrillar proteins. The losses due to the shrinkage on cooking however, will be greeter since the high temperatures involved will

cause protein denaturation and considerable lowering in water-holding capacity (Wierbicki *et al.,* 1954; Paul and Bratzler, 1955). In

all the treatments, the burger frozen at -40°C had a higher moisture content compared with that frozen at -18°C . This is due to the amount of drip that formed during thawing. In case of the fast freezing, the drip losses were less, while in the case of slow freezing the drip losses were greater (Judge *et al.,* 1990). The burger prepared from the prerigor beef had the lowest moisture content, due to the effect of thaw rigor phenomenon that result in marked shortening and excessive amount of drip (Lawrie, 1979). The high moisture content of the burger prepared from the acidified prerigor beef and frozen at -40°C which was not significantly different from that prepared from the 48 hrs post rigor beef could be attributed to the low pH value (Judge *et al.,* 1990). Arnold *et al.,* (1956), found that, during conditioning muscle proteins increase their water-holding capacity due to ions change. Generally, freezing at -40°C increases the lightness values. Here more light is reflected due to numerous small ice crystals that are formed during fast freezing, while freezing at -18°C causes large extracellular ice crystals, absorb more light and result in darker colour (Judge *et al.,* 1990).

The higher pH values of the prerigor beef burgers at different processing times could be explained by the effect of heating on glycolytic enzymes. (Judge *et al.,* 1990). The cooking process increases the pH values in all the treatments. The low pH values of the acid treated samples and of the 48 hrs post rigor samples were followed by an increase of 0.3-0.4 pH unit during cooking, probably due to denaturation changes in the protein (Bendall, 1946; Deatherage, 1963; Roberts and Lawrie, 1974). The freezing rate has no effect on pH values of the muscle.

In conclusion, the use of prerigor beef and a slow rate of freezing (-18°C) in the manufacture of beef burgers result in a low quality product. In contrast, beef burgers that are manufactured from acidified prerigor beef and frozen at -40°C (fast rate of freezing) are of high yield and better palatability characteristics.

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