PE4.93 Influence of packaging methods on beef quality traits 327.00

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Abstract— **The aim of this study was to evaluate how different packaging methods and aging times affect beef meat quality traits. The packaging methods tested were high-oxygen modified atmosphere (MAP), vacuum packaging, and vacuum skin packaging. Ten young bulls (16-25 months old) from two farms were slaughtered the same day according to standard routines at a commercial Swedish slaughter plant. *M. longissimus dorsi* (LD) from both sides were cut from the carcass day 1 *post mortem*, vacuum packed and aged 7 days. The LDs were cut into 3.5 cm steaks and stored in vacuum pack, MAP or skin pack for an additional 7 or 14 days. After storage the steaks were frozen (-20°C). Samples were heat treated in a water bath until an end temperature of 73°C. The perceived tenderness was shown to be significantly different between the packaging methods. The 7-day steaks and the MAP 21-day steaks were perceived to be the least tender, whereas the vacuum packed and skin packed steaks stored 21 days were perceived to be the most tender. The samples aged in MAP had lower water-holding capacity, higher shear-force and lower juiciness and flavour intensity than all other samples.**

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***Index Terms*— Ageing, beef, packaging, shear force, sensory analysis.**

I. INTRODUCTION

s the demand for food safety from consumers is Aincreasing, the meat packaging industry is growing in many countries. The most common consumer packaging types for beef in Sweden is modified atmosphere packaging (MAP) with the gas composition 80% O_2 and 20% CO_2. MAP has increased shelf life for chilled stored beef, giving the beef a stable red oxymyoglobin colour that is attractive to the consumer. However, several meat quality aspects are negatively affected by the high oxygen content in MAP [1, 9]. MAP with high oxygen content has also been shown to increase the breaking strength of individual beef muscle fibres [5]. Vacuum packing also extends shelf life of beef but the purple deoxymyoglobin colour and the purge loss in the vacuum bag is thought to be unattractive to consumers. Vacuum skin pack (skin pack) is a relatively new packaging method on the Swedish market which includes heating the upper packaging film just before its descent over the meat lying on a packaging tray, thus creating a vacuum. There have been a few studies on tenderness and shear force in skin pack. In their study, Taylor *et al*. significant differences in shear force between skin pack and MAP for beef, however, in pork meat, skin pack had significantly lower shear force compared to MAP. In the study by [10] the meat tenderization process in skin-packed beef steak was slower compared with vacuum-packed steaks, however, the difference was not significant. After 20 days of storage [1] found skin packed steaks to be less tender than steaks stored in vacuum for 19 days followed by two days in air. The purpose of this study was to find how shear-force, sensory quality and water-holding capacity differ between skin pack, vacuum pack and high-oxygen MAP judged instrumentally and sensorially.

II. MATERIALS AND METHODS

A. Animals, sample collection and water holding capacity

Ten young bulls of beef breed crosses, age 16-25 months from two farms were slaughtered the same day according to standard routines at a commercial slaughter plant. The carcasses were hung in the Achilles tendon at 4ºC overnight. Day 1 post mortem (PM) *M. longissimus dorsi* (LD) from the two sides of each animal were cut out and pH was measured to make sure that no LD had a pH >5.8. The whole LD muscles from the two sides were then vacuum packed and aged for 7 days at 2°C. Each LD was then unpacked and cut into 3.5-cm steaks, weighed and packed using the three different packaging methods, vacuum, vacuum skin pack and modified atmosphere (80% O_2 20% CO_2). The locations of the slices on LD were randomized and two samples were taken for each treatment on the same site of the two LD muscles from each individual. Samples were then stored in their respective package at 4°C for an additional 0,

7 or 14 days. The samples were unpacked, wrapped in aluminium foil and placed in a plastic bag before being frozen at -20°C until further analysis. For calculations of water-holding capacity, samples were weighed after each probable point of water loss, i.e. after cutting, storage, freezing and cooking.

A. B. Shear force measurement

The frozen samples were thawed overnight at 4°C and weighed. Samples were heat treated in plastic bags in a water bath until a core temperature of 72-73°C. Cooked samples were cooled in running tap water for 30 minutes and then stored at 4°C until the next day. Samples were then weighed to calculate cooking loss. Instrumental tenderness was measured using the Warner Bratzler method as described by [3]. The samples were cut into strips minimum 30 mm long with a 100-mm^2 (10x10 mm) cross-sectional area. The strips were parallel to the longitudinal orientation of the muscle fibres. Shear force was measured on a minimum of 12 strips from each sample with a Stable Micro Systems Texture Analyser HD 100 (Godalming, UK) equipped with a Warner Bratzler shear force blade with a rectangular shaped cutting area of 11 mm x 15 mm. The cutting blade was 1 mm thick and had a speed of 0.83 mm/s when cutting through strips. Shear force was analysed as peak force and total energy (area under the curve).

B. C. Sensory evaluation

Sensory analysis was performed with a sensory panel, composed of 8 semi trained assessors that tested the samples precooked in their home. The attributes tested were tenderness, juiciness, acidity and meat flavour, assessed on a scale from very low (1) to very high (9) intensity. The samples were thawed and heat treated as described above for shear-force measurements. The samples were then cut into slices 3-4 mm thick and all edges were trimmed to give a more uniform appearance. The slices were packed in tin foil sorted into two sessions so that replicates would not be tested in the same session. The samples were then handed out to the panel members for home testing at room temperature and the results were recorded using EyeQuestion Version 3.6 online.

C. D. Statistics

Samples were assessed using SAS version 9.1 (SAS Institute Inc., Cary, NC, USA) for statistical significance of the data using the packaging method/time as treatments (e.g. MAP 14 days) for comparative study of means and standard error. A mixed model was used with treatment as fixed factor and animal as random factor. The Satterthwaite method was used for degrees of freedom. For sensory analysis, panel member was aloso included as additional random factor.

III. RESULTS AND DISCUSSION

As expected, shear force values declined with increased storage time for vacuum-packed steaks from day 7 to day 21 (Table1). These results concur with other studies [6, 7]. The numerical values for peak force for MAP steaks were higher at both 14 and 21 days. However, there were no significant differences in shear force within each treatment between day 14 and 21. In the study by Barros-Velazques *et al.* [3] the level of tenderization for vacuum packed steaks compared with skin-packed steaks were higher, although the results were not significant. It could be noted that skin packed steaks were thinner than the other steaks after storage (Figure1). However, this difference in height was not significant when measured after thawing. In spite of the visible difference in thickness before freezing, which might have affected tenderness, no such effect was seen in our study.

Skin pack lost the least amount of water during storage and vacuum-packed steaks the most (Table1). Total water loss at 14 days did not differ significantly between treatments. At 21 days, vacuum packed and skin packed steaks had lower total loss compared with MAP. In contrast to our results Vázques *et al*. [10] found a higher water loss in skin pack compared with vacuum packed beef. In our study there were no such differences between skin pack and vacuum pack in total loss. The MAP steaks had a slightly lower water-holding capacity than steaks with the other packaging methods.

Using data from the sensory analysis, MAP steaks had lower tenderness at both ageing times. MAP steaks stored 21 days were as tough as vacuum-packed steaks stored 7 days (Table2). MAP steaks also had lower scores for meat flavour and lower juiciness at all ageing times. Meat flavour, juiciness and acidity did not differ significantly between skin pack and vacuum.

Storage in MAP seemed to slow down the tenderization process to such a degree that the sensory test showed the MAP 21-day samples as being on the same tenderness level as the 7-day samples. The 14-day samples were, however, more tender than the 7-day samples, suggesting that the tenderization process continues for a while in MAP although at a slower rate. When comparing the results for the 21-day and the 14-day samples for MAP steaks, the lower tenderness for the 21-day steak suggests that extended storage in MAP will not only slow down the tenderization process but actually reverse it. The sensory analysis showed that the perceived tenderness of the meat was also lower for MAP than the other packaging solutions.

The juiciness also decreased with longer storage time in MAP. This tendency could also be seen in the meat flavour and acidity traits although the tendency was not as strong. This result for juiciness is in agreement with the results found by Clausen

[1].

The skin pack and vacuum package showed very similar results throughout the different analyses. One of the advantages of skin pack is that the method is supposed to give less purge loss in the package compared to vacuum packing, which will lead to less fluid that can be substrate for bacterial growth. This could suggest that skin pack is a more desirable packaging solution, as the microbiological status has been proven to be better in skin pack when compared to vacuum package [10]. Previous studies have, however, shown that skin-packed steaks are less tender than vacuum-packed steaks [1, 10], though this was not found in our study.

IV. CONCLUSION

The results of this study show no clear differences between skin pack and vacuum pack for shear force, total loss, tenderness, acidity, juiciness, meat flavour. However, high-oxygen MAP negatively influenced shear force, water-holding capacity as well as the sensory attributes tenderness, meat flavour and juiciness compared with beef steaks packaged in vacuum or skin pack.

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Table 1. Effect of different packaging treatments on shear force and water holding capacity

		Treatment				
	Ageing	Skin pack	Vacuum pack	MAP	S.E.	P-value
Peak force (N)	7		67.9^{a}		11.4	0.012
	14	45.9^{bc}	51.3^{bc}	59.6^{ab}	11.2	
	21	49.8^{bc}	41.1^{c}	59.9^{ab}	11.2	
Total Energy (Nmm)	7		394^{a}		54.1	0.014
	14	294^{c}	316^{bc}	372^{ab}	52.7	
	21	312^{bc}	268^{c}	371^{ab}	52.7	
Storage loss (%)	14	2.0^{d}	4.3^{b}	3.3^{c}	0.20	0.001
	21	2.8^{c}	5.1^{a}	4.5^{b}	0.20	
Freezing loss (%)	7		4.1^{a}		0.37	0.001
	14	2.0^{b}	1.5^{b}	1.7^{b}	0.37	
	21	1.6^{b}	1.1^{b}	1.7^{b}	0.37	
Cooking loss (%)	7		26.6^{c}		0.84	0.005
	14	27.3^{bc}	27.1^{bc}	28.1^{ab}	0.84	
	21	28.2^{ab}	26.3^{c}	28.6^{a}	0.84	
Total loss (%)	7		30.7^{c}		1.09	0.006
	14	31.4^{bc}	32.9^{ab}	33.1^{ab}	1.09	
	21	32.7^{b}	32.5^{bc}	34.8^{a}	1.09	

Different letters indicate significant differences ($p<0.05$) between values of the same trait.

Table 2. Effect of different packaging treatments on sensory analysis

		Treatment				
	Ageing	Skin pack	Vacuum pack	MAP	S.E.	P-value
Tenderness	7		3.9^{e}		0.42	0.001
	14	5.3^{c}	5.5^{bc}	4.4^{d}	0.42	
	21	5.9^{ab}	6.1^{a}	3.9^{e}	0.42	
Acidity	7		5.3^{ab}		0.27	0.054
	14	5.4^{a}	5.3^{ab}	5.2^{ab}	0.27	
	21	5.5^{a}	5.4^{a}	4.9^{b}	0.27	
Meat flavour	7		5.4^{a}		0.27	0.001
	14	5.4^{a}	5.5^{a}	4.3^{b}	0.27	
	21	5.4^{a}	5.5^{a}	4.1^{b}	0.27	
Juiciness	7		5.4^{a}		0.28	0.001
	14	5.5^{a}	5.2^{a}	4.8^{b}	0.28	
	21	5.2^{a}	5.5^{a}	4.3^{c}	0.28	

Different letters indicate significant differences ($p<0.05$) between values of the same trait.

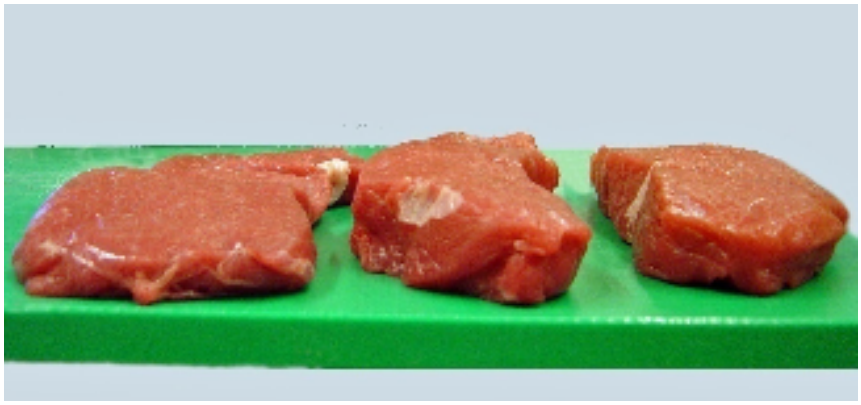

Figure 1. Observed differences in thickness between treatments after storage for 14 days from the same animal (from left to right skin pack, vacuum pack and MAP).