EVALUATION OF ALTERNATIVE PACKAGING METHODS FOR RETAIL BEEF CUTS

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Abstract – Packaging in the meat industry is evolving to keep up with the consumer's demands for meat quality which lasts longer and is more convenient (case ready products). In this trial meat was packaged in three different ways namely, 1) a primal cut which was first conventionally vacuum-packed (shrink bag), aged for 14 days, processed further into steaks and vacuum-packed to be aged for a further 7 days, 2) steaks which were processed into portions, packed using vacuum-skin packaging technology, and aged for 21 days, and 3) primals that were processed into portions, conventionally vacuum-packed as single steaks, and aged for 21 days. There was no difference in tenderness between the various methods but vacuum—skin packaging produced significantly less purge and had higher (more desirable) colour saturation and oxymyoglobin values once removed from packaging and displayed for 2 days.

Key Words – Meat quality, vacuum packaging, vacuum-skin packaging.

I. INTRODUCTION

The packaging of fresh meat is evolving and this is largely being driven by the need for conversion to centrally packaged meats and the need for increased convenience on the part of the consumer. In 2004, 60% of the packages in an audit in the US were case ready, which increased from 49% in 2002 [1]. One cost effective method is conventional vacuum-packaging (CVP) using multilayer, coextruded shrink bags. The visible purge, however, in CVP is thought to be unattractive to consumers [2]. The development of vacuum-skin packaging (VSP) has, however, improved this result due to the tight disposition of the plastic film on the surface of the meat. This prevents any wrinkles and subsequent purge conventionally forming in spaces around the meat [3].

Colour, as part of the visible selection criteria, also plays an important role at the point of purchase [4]. Both CVP and VSP result in the purple to brown deoxymyoglobin colour of meat which is associated by consumers with meat that is not fresh. Using VSP technologies has been shown to result in colour which is stable and meat is still able to bloom sufficiently when again exposed to air [5].

Some meat plants in the red meat industry use CVP to age whole primal cuts (like loins) before processing the cuts into portions at retail. The negative aspects of this process are the loss due to purge both at the first process and at the retail level. In addition, trimmings from this final processing cannot be sold as fresh meat and therefore contribute to a potential loss in total value of the initial cut. The cuts are also handled twice, increasing the risk of contamination and also reduced colour shelf life due to longer exposure to oxygen. Finally, extra time needed to reprocess the cuts is costly.

In this study we compare two conventional methods of packaging with the newer option of case ready VSP with regards to meat quality (tenderness, drip loss and colour).

II. MATERIALS AND METHODS

T-bone steaks were used, which includes parts of the *M. psoas major* (fillet) and *M. longissimus lumborum* (loin muscle). Only the *M. longissimus lumborum* was used for evaluation of tenderness and colour, while both muscles would have contributed to drip loss. The samples were packaged in one of three ways:

1) Conventional - Whole loin portions (bone-in) were aged for 14 days in shrink bags (B3050, Cryovac, Sealed Air, Africa (Pty) Ltd Kempton Park, South Africa) using CVP. The primal was then further processed and repacked individually into smaller shrink bags (CVP) and aged for a further 7 days.
2) Portioned - Loin portions were processed directly into 25 mm steaks that were

individually packed in shrink bags (CVP) and aged for 21 days.

3) Vacuum-skin packaging (VSP) - Loin portions were processed directly into 25 mm steaks that were individually packed using VSP technologies (Film: TC201, Darfresh, Sealed Air, Africa (Pty) Ltd Kempton Park, South Africa) and aged for 21 days.

All samples were aged at 2°C. The oxygen transmission rate (OTR) according to specifications were 17 cm^3/m^2, 24 h, at 23°C and <3 cm^3/m^2, 24 h, at 23°C for the shrink bags and top film of the VSP method, respectively. After ageing, samples were opened and the amount of purge determined. Preparation for colour and tenderness measurements followed.

The samples for tenderness measurement were frozen until the day of preparation and were thawed at 3°C before testing. Warner Bratzler shear force (WBSF) was performed on steaks oven broiled at 170°C to an internal temperature of 70°C [6]. Shear force was performed on 6 x 12.5 mm (diameter) cores using a Warner Bratzler shear device mounted on a Universal Instron apparatus (Model 4301, Instron Ltd, Buckinghamshire, England; cross head speed = 200 mm/min).

Muscle colour was measured with a Minolta meter (Model CR200, Osaka, Japan; 8mm diameter measuring area, diffuse 228 illumination and 0° viewing angel) on aged samples 60 minutes after the vacuum had been broken. Metmyoglobin and oxymyoglobin levels were also determined according to the method described by Krzywicki [7] and Tang *et al*. [8] on each sample by cutting thin slices of 2 grams of muscle on the surface of the meat sample. These were homogenized with 10ml of 2mM pH 7 phosphate buffer for 30 seconds and centrifuged at 20000g for 30 minutes. Supernatants were filtered through a Millipore filter with 0.45 µm pore diameter. Absorbance was recorded at 525 nm (isobestic point), 503 nm metmyoglobin (MetMb), 557 nm deoxymyoglobin (DeoMb) and 582 nm oxymyoglobin (OxyMb) using a Ubest-50 UV/VIS spectrometer (JASCO International Co., Tokyo, Japan) and used to calculate the ratios of MetMb, DeoMb and OxyMb. After initial colour measurement, samples were placed on Styrofoam trays, over wrapped with PVC and displayed in a refrigerator maintaining an ambient temperature of 2°C. Colour measurements followed the CIE colour convention, where the three fundamental outputs L*, a*, and b* were recorded. Colour saturation (S) or chroma was calculated as square root of $a^{*2} + b^{*2}$. L*, a*, b* and recording of myoglobin status were repeated for 3 days after initially breaking the vacuum seal. Values for S higher than 20 relate to the bright red colour of bloomed meat and S=18, S=14 and S<12, as dull, distinctly brown, and brown to gray-greenish brown, respectively [9].

Drip loss was determined as the amount of purge expressed as a percentage of the original weight of the cut.

Data of WBSF, drip loss and colour were subjected to analysis of variance for a split-plot design (GenStat® VSN International, Hemel Hempstead, UK [10]) with the 3 packaging methods (Conventional, Portioned and VSP) as whole plots and the days on display as sub-plots. Means for the interactions between the whole plots and the subplots were separated using Fisher's protected t-test least significant difference (LSD) at the 5% level [11].

III. RESULTS AND DISCUSSION

Packaging method had no significant effect on tenderness after 21 days ageing (Table 1). This was in agreement with previous reports [3, 12] but in contrast with Clausen [13] who found that CVP produced more tender steaks than the VSP technique after 19 days of ageing.

VSP showed an advantage of over 2 percentage units (3 times less; $P<0.05$) in the amount of purge over the other methods of packaging (Table 1), and there was no difference between the Conventional and Portioned groups. The latter was in spite of the fact that the drip loss of the Conventional method was calculated as the combined loss of the intact primal, and processed and repacked steaks. Drip loss collected after the first 14 days was 0.58% and most of the drip (2.82%) accumulated over the last 7 days after re-processing into single steaks. The advantage of VSP was in agreement with previous reports [3, 14] and could be explained by a firmer wrap over the surface of the meat

with VSP [12] as opposed to more space for purge in the wrinkles around the edges of the Conventional and Portioned products.

Table 1. Means value for shear force tenderness and drip loss for 3 packaging methods.

	Conventional	Portioned	VSP	SEM[1]
WBSF (Kg)	4.3	4.3	4.5	0.200
Drip loss (%)	3.40[b]	3.45[b]	1.09[a]	0.208

[a,b,c]Means in the same row with different superscripts differ significantly (P<0.05)
Conventional - Aged intact, processed into steaks and vacuum-packed individual portions.
Portioned – Processed into steaks, vacuum-packed in separate shrink bags and aged.
VSP– Processed into steaks, packed using vacuum-skin packaging technology.
[1]Standard error of means

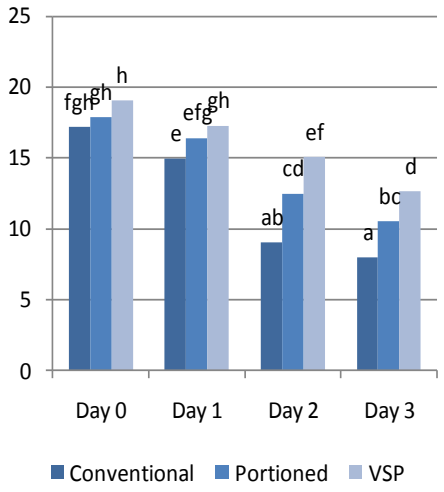

Figure 1. Colour saturation (S) for 3 packaging methods over 3 days of display.
[a-h]Bars with different superscripts differ significantly Interaction between packaging and days: P=0.014.

Figure 1 shows the interaction between packaging method and days of display on colour saturation (S). VSP showed numerically higher values for S than the other two methods on day 0 and 1 (*P*<0.05 between VSP and Conventional) and performed progressively better than both other methods on day 2 and 3 of display (*P*<0.05). Barros- Velazquez *et al*. [15] showed higher values for redness (a*) for freshly opened VSP samples (no display time) while Lagerstedt *et al*. [3] could not show significant differences between VSP and CVP samples, but reported that VSP samples maintained their purple red colour for 28 days under vacuum and bloomed very effectively after opening. The explanation for the latter as well as the initially and subsequent higher saturation values recorded in our study for the VSP method can probably be attributed to the lower OTR of the VSP film, and therefore less oxygen particles to be removed after packaging and higher maintenance of the enzyme reducing system compared to the conventional shrink bag systems [16].

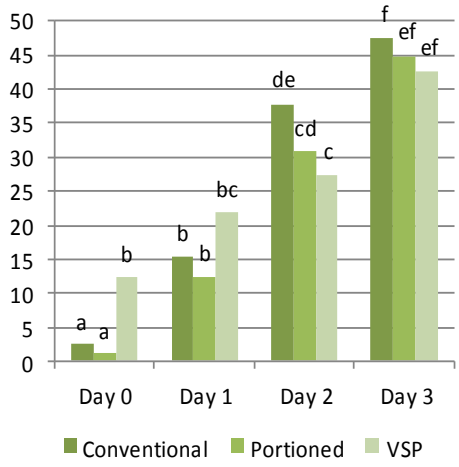

Figure 2. Metmyoglobin ratio for 3 packaging methods over 3 days of display.
[a-h]Bars with different superscripts differ significantly Interaction between packaging and days : P<0.001.

In contrast, instrumental colour readings (Figures 2 and 3) do not show favourable initial MetMb and OxyMb ratios for the VSP method as would have been expected considering the low OTR of VSP. However, subsequent high OxyMb ratios at day 2 and 3 correspond with better colour shelf life and preservation of colour potential for VSP (Figure 3). Relatively poor initial saturation value (<20) could indicate sub-optimal conditions at packaging or poor preservation during storage which could explain the contradiction between initial OxyMb and MetMb.
The reason why the Portioned method showed saturation values that were the closest to the VSP treatment and higher than the Conventional method is difficult to explain, apart from the fact that the latter samples were aged for 14 days

when they were processed and exposed to atmosphere again before being repacked and aged for a further 7 days. This could affect the ability to consume the oxygen in the package as well as the MetMb reduction ability and subsequent ability to bloom after re-opening [17].

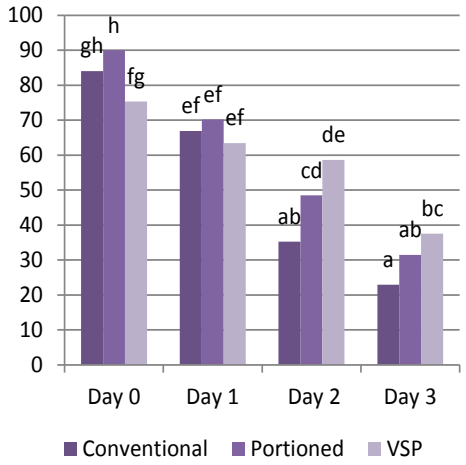

Figure 3. Oxymyoglobin ratio for three packaging methods over 3 days of display.
[a-h]Bars with different superscripts differ significantly Interaction between packaging and days : P<0.001.

IV. CONCLUSION

The significant advantage of VSP in saving on drip loss, allows the processor to portion meat directly after boning and to gain the full advantage of ageing. As well as being visually more attractive to the consumer at the point of purchase regarding purge, colour shelf life after breaking the vacuum also seems to favour VSP, allowing meat to bloom sufficiently to produce the bright red oxymyoglobin colour that consumers associate with fresh meat.

ACKNOWLEDGEMENTS

The Analytical Services staff of ARC-API, Irene.
RMRDSA and THRIP, South Africa for funding.

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