INFLUNCE OF PACKAGING AND STORAGE ON COLOUR AND WATER HOLDING CAPACITY OF FRESH MUSCLES

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Abstract

The Colour (myoglobin content) and water holding capacity of fresh Longissimus dorsi muscles of beef and pork were assessed using spectrophotometer (sp 8 – 100) and pressure (spring balance) respectively. These muscles were packaged differently and stored under ambient room and refrigerator at 28° ± 0.9°C and 5°C respectively for two days at Oh, 24h and 48h. Samples packaged in high density polythene and stored in refrigerator had higher myoglobin retention than low density polythene and unpackaged stored in ambient room. Samples stored in 24 h and 48 h showed an increase and a decrease in water holding capacity values respectively over Oh storage. Similarly, samples stored in refrigerator had higher water holding capacity value than ambient room, but not statistically significant ($p>0.05$). On species differences pork samples had significantly ($p<0.05$) higher water values than beef samples.

Introduction

The depth of colour of the muscles depends upon the concentration of the myoglobin, which is the major pigment of muscles. At higher pH the myoglobin is darker in colour, but the colour

brightens with the postmortem drop in pH (Lawrie, 1991). Muscles vary in myoglobin content based on their physiological roles, animal's age, the breed, in different muscles in the same animal. More frequently use muscles have higher myoglobin content due to the need for myoglobin to store and delivery oxygen in the muscles (Miller, 1994). However, anaemic condition reduces the amount of myoglobin. On the basis of selection, consumers prefer fresh meat with attractive lean colour but the rate of its sale is directly related to the degree of discolouration.

The reduced colour of fresh meat (myoglobin) is purple red (beef) to red pink (pork). However, on exposure to oxygen it forms unstable complex compound (oxymyoglobin) which is bright red. This cherished colour of beef can be prolonged for several days by contact with high concentrations of oxygen and carbon dioxide (Alugwu and Obanu, 2009). However, the appearance of oxidized form brown metmyoglobin usually signals the end of display life for fresh meat (Taylor, 1985). Oftentimes it occurs before off-odours associated with microbiological spoilage. The rate of colour deterioration and water holding capacity of the muscles are affected by the pre-slaughter, post slaughter history of the carcass and packaging materials as storage progresses (MacDougall, 1977). Similarly water holding capacity refers to water entrapped in cells of foods. It is retained during application of external forces such as cutting, heating, grinding or pressing. However, some loss of moisture occurs even during the mildest application of these treatments because a portion of the water present is in the free form. Many of the physical properties of meat are partially dependent on it. The water holding capacity of muscle tissue has a direct effect on the shrinkage of meat during storage. Muscle tissues that

exhibit poor water holding capacity, loss moisture from exposed muscle surface and consequently suffer great loss of weight during storage (Ikeme, 1990). It is an attribute of obvious importance because it affects the appearance of the meat before cooking, its behaviour during cooking and juiciness on mastication (Lawrie, 1991). In muscle, the water binding of the tissue is greatly influenced by the solubility and state of its myofibrillar and sarcoplasmic proteins.

Consequently, ant mortem stress conditions such as vigorous exercise or fight, fasting, hot and cold temperatures and fear cause glycogen levels to be low and there is insufficient substrate and therefore insufficient adenosine triphosphate hydrolysis to produce a low pH desired to inhibit the growth of micro organisms (Hultin, 1985). Therefore, this study desires to compare the efficiency of high density and low density polythene packages of 0.40cm and 0.25cm thickness respectively in fresh muscles shelf-life extension.

Materials and Methods

Muscles used: Longissimus dorsi muscles of beef and pork were purchased from Nsukka Urban market abattoir immediately after slaughter and dressing in pre-rigor state, trimmed of fat, connective tissues, sliced evenly ($2cm^3$) and divided into six batches. Two batches were packaged in high-density polythene and the other two in low-density polythene and the last two batches unpackaged. One of each pair was stored in ambient room ($28°\pm0.9°c$) conditions and the other of each pair in a refrigerator ($5°c$) for 2days and sampled at 0h, 24h and 48h.

Determination of Myoglobin Content. This was determined as described by Alugwu and Obanu (2005). A known quantity of each sample was ground to smooth consistency with plastic mortar

and pestle. Thereafter, 1 gram of the ground sample was weighed into a beaker and homogenized with 10ml of 40 percent pyridine solution. This was thoroughly mixed and left to stand for 30min. and later filtered through Whatman (no. 1) paper. The extract was then scanned in spectrophotometer (model sp8-100) with reflectance gadget through visible light wavelength (from 700nm-300nm) at a rate of 60nm/min using 40 percent pyridine solution as standard solution (blank)

Water Holding Capacity Determination. This was determined as described by Trout (1988). Two grams of the samples were weighed on whatman (no.1) filter paper. The sample and paper were placed between two metal plates and pressed in a spring balance at a pressure of $19.6N/M^2$ for 30min. At the end of this time period the plates were separated and the water holding capacity of the sample was taken as the gain in weight of the paper.

Statistical Analysis : Two complete replications were conducted. Myoglobin contents and water holding capacity of the sample were evaluated for significance by means of analysis of variance (ANOVA) using nested design by Gomez and Gomez (1984). Dunican's multiple range test (Dunican, 1975) was used to discriminate among the means

Results

The peak absorbency of the extracted myoglobin was at wavelength of 408nm in spectrophotometer (model sp 8-100) as shown in Fig .1 .

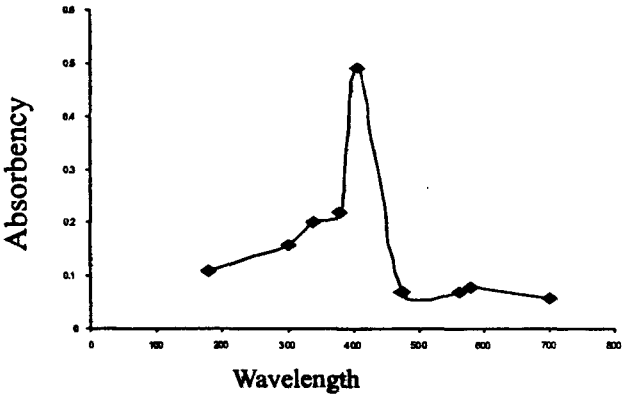

Fig.1 Spectrophotometric Scanning of myoglobin Extract

Myoglobin content measured as optical density as show in Table 1. It declined significantly ($p<0.05$) as storage progressed as show in Table2.

Discussion

Similarly, comparison of effects of packaging materials on myoglobin content shows that high density polythene packaged samples had significantly ($p<0.05$) higher myoglobin retention than low-density polythene or unpackaged samples. The lower myoglobin retention of low-density polythene packaged muscle could be attributed to its higher oxygen permeability, which activates residual activity of oxygen utilizing enzymes, and this result in the denaturation of the globin moiety (Lawrie, 1991).

Also muscles stored in the refrigerator though not significant ($p>0.05$) had higher myoglobin content than muscles stored under ambient room conditions. This difference could be attributed to lower temperature of refrigerator which delays metmyoglobin formation through the suppression of residual activity of oxygen utilizing enzymes (Lawrie, 1991).

On species differences, beef had slower myoglobin loss than pork under both storage conditions. This could be due to faster rate of formation of

oxymyoglobin of freshly cut surface of beef than that of pork (Haas & Bratzler, 1965) as a result of much greater myoglobin content of beef.

Table 1: Changes in optical density of longissimus dorsi of beef and pork during storage in the refrigerator and ambient room conditions

Storage	Species	Packaging		Storage period	
condition		Materials	0H	24H	48H
Ref	Beef	UN	0.870±0.004	0.416±0.004	0.354±0.008
	"	HD	0.870±0.006	0.560±0.007	0.411±0.012
	"	LD	0.870±0.003	0.463±0.006	0.373±0.014
V	Pork	UN	0.580±0.006	0.381±0.013	0.307±0.008
	"	HD	0.580±0.008	0.401±0.008	0.342±0.008
	"	LD	0.580±0.004	0.390±0.006	0.315±0.007
Ambient	Beef	UN	0.870±0.007	0.318±0.006	0.258±0.006
	"	HD	0.870±0.006	0.385±0.007	0.323±0.010
	"	LD	0.870±0.008	0.350±0.006	0.279±0.014
V	Pork	UN	0.580±0.010	0.292±0.011	0.243±0.006
	"	HD	0.580±0.006	0.330±0.006	0.272±0.006
	"	LD	0.580±0.007	0.310±0.006	0.259±0.013

Table 2: Effect of packing materials and storage conditions on myoglobin content of longissimus dorsi of beef and pork

Packaging		Beef		Pork
materials	Ref	Ambient	Ref	Ambient
UN	$0.547^{c}\pm0.252$	$0.482^{c}\pm0.302$	$0.423^{c}\pm0.126$	$0.372^{c}\pm0.163$
HD	$0.614^{a}\pm0.209$	$0.526^{a}\pm0.268$	$0.441^{a}\pm0.111$	$0.394^{a}\pm0.146$
LD	$0.569^{b}\pm0.237$	$0.502^{b}\pm0.287$	$0.428^{c}\pm0.122$	$0.383^{b}\pm0.154$

+ values are mean ± standard deviations of three determinations

+ values within the same column with different superscript are significantly different ($p<0.05$).
UN – Unpackaged
HD – High density polythene
LD - Low density polythene

There is an increase in 24h evaluation as well as a decrease in 48h evaluation over the 0h evaluation of water holding capacity of beef and pork as shown below:

Tables 3: changes in water holding capacity of Longissimus dorsi of beef and pork during storages in the refrigerator and Ambient room conditions.

Storage	Species	Packaging	Storage period		
condition		Materials	0H	24H	48H
Ref	Beef	UN	0.320±0.014	0.345±0.035	0.200±0.014
	"	HD	0.320±0.014	0.360±0.014	0.310±0.028
	"	LD	0.320±0.014	0.350±0.014	0.255±0.007
V	Pork	UN	0.330±0.014	0.350±0.014	0.250±0.028
	"	HD	0.330±0.014	0.385±0.007	0.320±0.028
	"	LD	0.330±0.014	0.360±0.028	0.270±0.028
Ambient	Beef	UN	0.320±0.014	0.330±0.028	0.175±0.021
	"	HD	0.320±0.014	0.360±0.014	0.295±0.007
	"	LD	0.320±0.014	0.350±0.028	0.260±0.000
V	Pork	UN	0.330±0.014	0.340±0.014	0.260±0.014
	"	HD	0.330±0.014	0.370±0.028	0.345±0.014
	"	LD	0.330±0.014	0.350±0.042	0.305±0.007

The increase could be caused by changes in the ion-protein relationships leading to the net increase in charge through absorption of potassium ions (k^+) and release of calcium ions (ca^{2+}). Moreover, slaughtering of an animal lead to death, loss of adenosine triphosphate (ATP) and subsequent actomyosin formation as muscles go into rigor mortis and resultant loss of water holding capacity of the muscles (Lawrie, 1991). Table 4 has shown that meat samples stored in the refrigerator had significantly ($p<0.05$) higher value of water holding capacity than the ambient stored samples. This difference could be attributed to higher temperature and lower relative humidity of the ambient room than the refrigerator and this results in more moisture loss from the meat stored under ambient room. (Kinsman et al, 1994).

On effects of species, pork had higher water holding capacity values than beef. This difference could be attributed to the higher content of intra-muscular fat in pork, which loosens up the microstructure, thus allowing more water to be entrained.

Table 4: Effects of packaging materials and storage conditions on water holding capacity of Longissimus dorsi of beef and pork

Packaging		Beef		Pork
materials	Ref	Ambient	Ref	Ambient
UN	$0.288^{c}\pm0.072$	$0.275^{c}\pm0.079$	$0.310^{c}\pm0.050$	$0.310^{c}\pm0.041$
HD	$0.330^{a}\pm0.028$	$0.325^{a}\pm0.031$	$0.345^{a}\pm0.035$	$0.348^{a}\pm0.022$
LD	$0.308^{b}\pm0.044$	$0.310^{b}\pm0.043$	$0.320^{b}\pm0.045$	$0.328^{b}\pm0.031$

values are mean ± standard deviations of three determinations

+ values within the same column with different superscript are significantly different ($p<0.05$).

UN – Unpackaged

HD – High density polythene

LD – Low density Polythene

Conclusion:

The study has shown that high density polythene packaged samples had significantly ($P<0.05$) higher myoglobin retention and water holding capacity than low density polythene packaged or

unpackaged samples. Similarly samples stored in refrigerator had higher myoglobin content and water holding capacity than those stored under ambient-room conditions. From the research pork muscles had higher + myoglobin contents and water holding capacity than beef muscles. Consequently, high density polythene packaged samples had more shelf-life extension than samples packaged in low density polythene or unpackaged. Therefore, I strongly recommend high density polythene and refrigeration for fresh muscle packaging and storage because of their good quality attributes.

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