FACTORS AFFECTING THE PHYSICO- CHEMICAL QUALITY AND FATTY ACID PROFILES OF MUTTON AT POINT OF PURCHASE IN THE EASTERN CAPE PROVINCE, SOUTH AFRICA

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Abstract – This study determined the physico-chemical quality and fatty acid profiles of mutton cuts purchased from rural and urban shops and butcheries in five municipalities in the Eastern Cape province of South Africa. Five hundred and ten samples were collected in four seasons and transported to the laboratory for meat quality and fatty acid analysis. L* values were lowest (24.7±0.49) in winter and highest (32.2±0.49) in spring. Loin and sirloin cuts had the lowest docosapentaenoic and linoleic acids. These fatty acids have a cholesterol reducing effect, a desirable characteristic for health-conscious consumers. Fatty acid profiles and physico-chemical quality of mutton were significantly affected by season and meat portion and not necessarily by the locality and class of shop.

Key words: Meat quality, season, place of purchase.

I. INTRODUCTION

Physico-chemical characteristics are important determinants of meat quality and its acceptability by consumers. Among the physical and chemical attributes of meat, ultimate pH gives a good indicator of meat colour. Other physical attributes include tenderness, colour, cooking loss, flavour and juiciness of the meat. At the point of purchase, the red colour appeal of meat is important to consumers as it denotes freshness and quality [1]. The marketability or volume of meat sales from display shelves depends on immediate visual meat quality and subsequent on-plate-on-palate feeling. The critical points of appraisal of meat quality also encompass views on healthiness, price and the combination of the aforementioned factors influences the decision to repurchase. Meat is expected to have a desirable colour that is uniform throughout the entire cut. However, the surface of meat changes from red to brown during retail display due to the formation of metmyoglobin [2] and other individual factors prior to purchase [3]. This, in a way reflects changes in pH, overall flavour, tenderness, cooking loss and juiciness of the meat. In a study by [4], the place of purchase was ranked highly in assessing quality of meat in the shop. [3] also found that consumers perceived the place of purchase as a crucial quality cue, with health conscious consumers preferring meat from upmarket shops. Therefore, it is important to determine if the place where consumers purchase meat and season have an effect on colour, cooking loss and tenderness of the mutton cuts. It should be kept in mind that fatty acids form an important integral part of meat quality. The objective of this study was to determine factors that affect the physico-chemical attributes and fatty acid profiles of mutton cuts from different retailer type in South Africa.

II. MATERIALS AND METHODS

Study site

The study was conducted in five municipalities situated in the Eastern Cape Province of South Africa. Selected areas were categorized based on population concentration and grouped into urban (high population density) and rural (low population density).

Table 1. Least square mean values (± s.e) for colour, pH, tenderness and cooking loss of mutton from different place of purchase

Parameter	Urban	Rural	Significance level
N	265	245	
Lightness (L*)	28.6 ± 0.42	28.8 ± 0.50	NS
Redness (a*)	16.6 ± 0.68	15.1 ± 0.81	NS
Yellow (b*)	11.0 ± 0.13	10.8 ± 0.16	NS
pH	6.0 ± 0.02	6.0 ± 0.02	NS
WBSF (N)	19.2 ± 0.45	19.6 ± 0.54	NS
Cooking loss%	35.0 ± 0.68^{a}	32.0 ± 0.81^{b}	**

^{ab}Means in the same row with different superscripts are significantly different ($p < 0.05$)

Table 2. Least square mean values (± s.e) for colour (L*, a* and b*), pH, tenderness and cooking loss of mutton in different seasons

	Season			
	Spring	Summer	Autumn	Winter
N	140	126	132	112
Lightness (L*)	32.2±0.49[a]	26.9±0.49[b]	26.8 ±0.47[b]	24.7±0.49[c]
Redness (a*)	17.8±0.85	14.8±0.86	15.3±0.81	15.9±0.86
Yellowness (b*)	10.8±0.19	10.9±0.19	11.1±0.19	10.7±0.19
pH	5.9±0.02[c]	5.9±0.02[c]	6.2±0.02[b]	6.4±0.02[a]
WBSF (N)	17.7±0.65[c]	20.7±0.66 [ab]	19.7±0.63[b]	21.2±0.66[a]
Cooking Loss (%)	28.8 ±0.88[d]	35.2±0.89[b]	37.5±0.85[a]	30.7±0.89[c]

[a bcd]Means in the same row without the same superscripts are significantly different ($p < 0.05$)

Animal management

Five hundred and ten samples were collected in four seasons i.e. summer (126 samples), autumn (132), winter (112) and spring (140). Each sample was made up of the seven cuts/portions; chump, leg, loin, rib, shoulder, brisket chops, trotters. Each sample's portion/cut was divided into two equal parts. One part was immediately used for point of purchase determination of colour (L*, a* and b*), pH, cooking loss and tenderness. The other part was immediately delivered to the laboratory in a cooler box containing ice at ≤ 4oC and stored at -20oC. Total lipids from muscle samples were quantitatively extracted, according to the method of [5] using chloroform and methanol in a ratio of 2:1.

Statistical analysis

Physico-chemical meat quality parameters (pH, L*, a* and b*, cooking loss, WBSF values), individual and group fatty acids were analysed. A randomised complete block design was used and analysis of variance (ANOVA) was done using PROC GLM in SAS (2011).The following model was used; $Y_{ijkl} = \mu + M_i + P_j + S_k + E_{ijkl}$.

III. RESULTS AND DISCUSSION

Effect of place of purchase on physico-chemical attributes of mutton

According to [3] it is imperative for the meat industry to have knowledge on what quality cues consumers use when purchasing meat and how they can use this information to remain use intrinsic cues such as colour and extrinsic cues such as quality assurance, place of purchase and price. Place of purchase was ranked as the most competitive. At the point of purchase consumers important in assessing meat quality in the shop [4] and [3] followed by colour. In this study, there were no significant differences on L*, a*, b* values, pH, and tenderness of the meat that was bought from urban and rural shops (Table 1). This can be attributed to good meat handling practices within the industry especially when meat is fresh. However, observed differences in cooking losses may be as a result of differences in storage environment and shelf time.

Effect of season on physico-chemical attributes

Results of seasonal effects on physico-chemical attributes are presented in Table 2. There were significant seasonal effects ($P < 0.05$) on the L*, tenderness, pH and cooking loss of meat. However, b* and a* values of the meat were not affected by season. The pH was higher in winter and autumn and lower in summer and spring. These results were also reported by [7] in light lambs and could be due to high glycogen levels in muscles which is influenced by the fat-content of the feeding regime. The L* values for meat purchased in winter were the lowest, showing a darker colour. This could be a result of pre-slaughter cold stress as the meat had high ultimate pH, low L* values and dark colour. This is in line with results by [8] where mutton samples taken in the cold, wet season were darker than meat samples from hot, wet season. According to [9], high ultimate pH values are usually associated with dark cuttings. Mutton samples purchased in winter also had the highest values of WBSF values.

Table 3. Least square mean values (± s.e) for colour, pH, tenderness and cooking loss of mutton from different cut/portion

Parameters	Lightness (L*)	Redness (a*)	Yellowness (b*)	pH	WBSF (N)	Cooking Loss (%)
N	510	510	510	510	510	510
Brisketk	25.2±1.26^{c}	15.6±0.62^{c}	10.8±0.49^{cd}	6.1±0.05^{b}	22.8±1.68^{bc}	31.9±1.98^{d}
Chump	28.9±1.35^{a}	15.0±0.67^{c}	11.4±0.53^{c}	6.2±0.06^{a}	19.9±1.79^{d}	35.1±2.13^{c}
Leg	26.1±0.54^{b}	15.8±0.35^{bc}	10.9±0.21^{c}	6.1±0.02^{b}	19.2±0.72^{de}	36.6±0.85^{bc}
Loin	24.9±1.08^{d}	14.7±0.53^{de}	11.8±0.42^{bc}	6.1±0.05^{b}	21.5±1.43^{c}	34.1±1.69^{c}
Rib	25.1±0.71^{c}	15.9±0.35^{b}	10.4±0.28^{e}	6.2±0.03^{a}	18.9±0.94^{e}	30.9±1.12^{d}
Shoulder	26.9±0.59^{b}	15.1±0.29^{c}	10.9±0.23^{c}	6.2±0.03^{ab}	21.2±0.79^{c}	34.0±0.93^{cd}
Sirloin	25.3±1.60^{c}	17.4±0.79^{a}	10.5±0.63^{e}	5.9±0.07^{c}	18.9±2.13^{e}	34.8±2.53^{c}
Trotter	30.4±2.78^{a}	30.4±2.78^{a}	13.1±1.08^{a}	6.3±0.12^{a}	24.9±2.15^{b}	39.5±4.38^{ab}

^{abcd}Means in the same column with different superscripts are significantly different ($p < 0.05$)

Meat samples bought in summer and in autumn had the highest percentages of cooking loss. During hot seasons temperatures are high and may result in higher thawing loss and cooking losses. The pH of mutton samples purchased in winter and autumn in this study were between 6.2 and 6.4. According to [9], higher pH (> 5.8) leads to undesirable meat colour which is unattractive to consumers.

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Effect of cut/portion on physico- chemical attributes

There were significant differences between the different meat cuts in terms of colour, pH, tenderness and cooking loss (Table 3). Higher values of cooking loss and lower values of WBSF were observed in the trotter, leg chop, and chump. Trotters had higher values of L*, a* and b* values and pH compared to other meat parts followed by the chump. The loin had the lowest a* and L*values. The rib and sirloin chops had lowest WBSF values, indicating that they were softer as compared to other meat parts with rib being tougher. Rib chops had the lowest percentage values of cooking loss. Ribs are made up of less muscle fibre than other cuts. The differences in physico-chemical attributes correspond to differences in muscle type and pigmentation between abdominal, pectoral, pelvic and thoracic mutton cuts. According to [9], meat ultimate pH is widely used as an indicator of meat quality and carcasses are often categorised according to pH. Briefly, low pH_u meat ($pH_u < 5.8$) is most ideal with regards to consumer acceptability and palatability and high pH_u meat (pH_u 6.2) is darker in appearance and more susceptible to microbial spoilage. High pH also affects colour and meat tenderness [9].

Table 4. Effect of cut/portion on fatty acid profile of mutton								
	Brisket	Chump	Shoulder	Leg	Loin	Rib	Sirloin	Trotter
N	510	510	510	510	510	510	510	510
Vaccenic	1.1 ± 0.07^{ab}	1.3 ± 0.05^{b}	1.2 ± 0.03^{ab}	1.3 ± 0.04^{b}	1.2 ± 0.05^{ab}	1.2 ± 0.04^{ab}	1.0 ± 0.09^{a}	1.2 ± 0.10^{ab}
Linoleic	4.4 ± 0.47^{b}	4.3 ± 0.31^{b}	4.6 ± 0.22^{bc}	4.8 ± 0.24^{bc}	3.3 ± 0.32^{ab}	5.1 ± 0.27^{c}	2.7 ± 0.61^{a}	4.3 ± 0.59^{b}
CLA	0.5 ± 0.05^{ab}	0.6 ± 0.03^{b}	0.5 ± 0.02^{a}	0.5 ± 0.02^{a}	0.5 ± 0.03^{a}	0.5 ± 0.03^{a}	0.5 ± 0.06^{ab}	0.5 ± 0.06^{ab}
α-Linolenic	1.5 ± 0.16^{b}	1.2 ± 0.10^{a}	1.3 ± 0.07^{ab}	1.4 ± 0.08^{b}	1.3 ± 0.11^{ab}	1.9 ± 0.09^{c}	1.3 ± 0.20^{ab}	1.3 ± 0.20^{ab}
Arachidic	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.02	0.1±0.02
Eicosatrienoic	0.1±0.09	0.1±0.10	0.1±0.12	0.1±0.12	0.1±0.07	0.1±0.13	0.1±0.10	0.1±0.09
Heneicosanoic	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01	0.1±0.01
Oleic	37.9 ± 0.88^{a}	39.4 ± 0.5^{b}	38.6 ± 0.42^{ab}	39.1±0.45	39.3 ± 0.6^{b}	37.3 ± 0.51^{a}	38.8 ± 1.15^{ab}	38.8 ± 1.12^{ab}
Docosapentaenoic	0.4 ± 0.06^{b}	0.3 ± 0.04^{ab}	0.4 ± 0.03^{b}	0.4 ± 0.03^{b}	0.3 ± 0.04^{ab}	0.6 ± 0.03^{c}	0.2 ± 0.08^{a}	0.3 ± 0.07^{ab}
Docosahexanoic	0.1 ± 0.03^{a}	0.1 ± 0.02^{a}	0.1 ± 0.01^{a}	0.2 ± 0.02^{b}	0.1 ± 0.02^{a}	0.2 ± 0.02^{b}	0.2 ± 0.07^{b}	0.1 ± 0.04^{a}

[abcd]Least square mean values in the same row with different superscripts differ ($p < 0.05$); CLA= conjugated linoleic acid

The pH in mutton is expected to range between 5.75 and 6.00. Therefore, the observed pH in current study ranging from 5.9-6.3 could be considered higher and unacceptable. Winter season was observed with high pH (6.4) values and high tenderness values. Meat tenderness has been reported to be related to ultimate (pH_u) value and meat colour [9].

IV. CONCLUSION

Place of purchase did not affect meat quality attributes and cannot be used as a good indicator of meat quality. However, season and meat cut/ portion effect meat quality and fatty acid profiles of mutton cuts.

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