SENSORY PROFILES OF MUTTON FROM DIFFERENT REGIONS IN SOUTH AFRICA

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Executive summary

The ARC Sensory Analysis was tasked to evaluate the flavour attributes of mutton from the Karoo region. Descriptive terminology was developed by a trained sensory panel for Merino and Dorper mutton from De Aar, Carnarvon, Kalahari, Namibia and Free State. Panellists were carefully selected and trained to assess the flavour and texture attributes and to develop terminology for describing the different Karoo lamb samples. The objective of the study was to determine if a sensory difference was detectable between mutton produced in major production regions in South Africa and Namibia.

The panellists were trained on the mutton samples from the different regions and were exposed to the grazing plants eaten by sheep in the Karoo region. The grazing plants were selected based on recommendation made by Tommy Buys of the Department of Agriculture in the Northern Cape i.e. Carnarvon. A 'tea' was brewed with tips and fine twigs of the grazing plants and was served hot to the panel, who developed descriptive terms to describe the flavour of each plant. The panel did not evaluate the grazing plants sensory in the tasting booths.

The mutton was evaluated under red-light conditions in individual sensory booths. Eight replications were applied to ensure reliability of the data.

The results showed that the grazing plants from the Karoo and Karoo-like regions could impart herbal and musty flavour attributes to mutton meat from sheep breeds of these regions. The herbal attribute was found to contribute positively to the cooked flavour of the meat and the musty flavour attribute contributed negatively to the cooked flavour of the meat.

A 2-way ANOVA was performed with breed and region as the main effects and indicated no significant differences between the Merino and Dorper breeds. The ANOVA of the combined sensory data per region indicated significant differences between the different regions.

Principal Component Analysis (PCA) was applied to identify any factors differentiating between the mutton samples and explained 93 % of the total variation in the data.

The PCA indicated that mutton from the De Aar region was most intense in the herbal component, although not significantly so, and had a slightly coarser texture that was not very tender. Mutton from the Namibia region was most intense in the musty flavour component with a slightly more tender texture. Mutton from the Carnarvon and Kalahari regions, which are situated in the heart of the Karoo, differed only slightly from mutton from Namibia and mutton from De Aar regions, respectively. However, these differences were not very distinct. The mutton from Carnarvon and Kalahari had a fairly intense mutton aroma and flavour and both the herbal and musty attributes were present in the meat. Some textural differences were found between the breeds and regions.

With regard to the sensory profiles of mutton from the Karoo region (Carnarvon, De Aar and Kalahari), definite flavour characteristics were present in the meat which can only be due to grazing plants in these areas that are consumed by sheep. However, this was not significantly different to mutton from adjacent Free State and Namibia regions respectively.

INTRODUCTION

Sheep is produced in all the regions of South Africa, except the far northern areas. Since South African lamb and mutton are mostly produced on natural pastures, certain breeds are specifically bred for arid areas such as the Karoo region, which is known for it harsh temperatures and dry conditions. According to folklore, sheep meat from these regions has distinctive flavours and aromas. Lamb and mutton from the Karoo regions have always been associated with a unique and desirable herby flavour, being described as much sought after by South African consumers, who prefer the unique flavour of pasture fed mutton and are prepared to pay more for it.

Lamb and sheep from the Karoo region graze on bossies (indigenous plants) found in the Karoo. The Karoo bossies provide feed for animals in the winter as grass can only be found in rainy seasons in the Karoo, but bossies are found year round and endure heat, cold, wind and hail. There are various types of Karoo bossies and each type is specialised in different ways to survive the harsh conditions of the Karoo. Estler, Milton & Dean (2006) state that karoo bossies are responsible for the distinctive flavour of Karoo lamb and Karoo game. Karoo bossies are palatable and meet the nutritional needs of the grazing animals year round (Le Roux, Kotze, Nel & Glen, 1994). Mutton from the Karoo region and adjacent Free State and Namibia were evaluated for their sensory properties. Mutton from Namibia was included in this study as it is mostly consumed in South Africa.

The Sensory Analysis Unit of the ARC evaluated the aroma, texture and flavour attributes of Dorper and Merino mutton leg cuts from different regions in South Africa.

OBJECTIVES

- To determine whether there is a statistically significant detectable sensory difference between mutton produced in major production regions in South Africa and Namibia.

- To compare the fatty acid profiles of mutton fat from the different regions with that of "bossies" from the Karoo region

EXPERIMENTAL PROCEDURE

Mutton

The leg cuts of mutton Dorper and Merino of age class C with a fat class 2 from five production regions i.e. Carnarvon, De Aar, Namibia, Free State and Kalahari were obtained by the *"Just Lamb"* retailer. It was delivered, frozen and vacuum packed, to the Sensory Analysis and Human Nutrition Unit, Meat Industry Centre and kept at -20°C until analysed. The samples evaluated were numbered at random and represented the following treatments:

1. Dorper De Aar
2. Dorper Carnarvon
3. Dorper Kalahari
4. Dorper Namibia
5. Dorper Free State
6. Merino De Aar
7. Merino Carnarvon
8. Merino Free State

Six grazing plants commonly eaten by sheep from the Karoo and Karoo-like regions were obtained for training purposes only and analysed. The grazing plants were selected based on recommendation made by Tommy Buys of the Department of Agriculture in the Northern Cape i.e. Carnarvon.

1. Silwerkaroo
2. Skaapbossie
3. Kapokbossie

4. Rivierganna
5. Ankerkaroo
6. Perdebos

TASTE PANEL PROCEDURES

Sensory analysis procedures

The trained sensory panel (n=10) was used to perform Quantitative Descriptive Analysis (QDA). The purpose of QDA is to determine how products differ in specific sensory characteristics. The panellists were selected to participate based on their participation in previous descriptive sensory (meat) panels, taste and smell acuity, interest, ability to discriminate between the four basic tastes and availability for the entire study. The panel's previous sensory evaluations included meat and meat products (pork, beef, lamb and chicken), fats and oils, dairy products, beverages and many more.

During the training sessions, panellists were exposed to six grazing plants commonly eaten by sheep from the Karoo and surrounding regions as well as meat samples to be evaluated, in order to develop relevant terminology (Table 1). A 'herbal-tea' was made from each plant and then used to train the panel on aroma attributes. They identified descriptive words to describe the aroma and flavour profile of the samples (Table 2). The ten panellists each received a representative sample of mutton meat of the different regions (treatments) and were then trained to increase their sensitivity and ability to discriminate between specific samples and sensory attributes. In order to ensure that panellists were not influenced in any way, no information with regard to the nature of the samples was provided. A clear definition of each attribute was developed to describe the specific attribute to be evaluated. Panellists were instructed to give a detailed description of the aroma, flavour and aftertaste attributes of the mutton meat samples.

Panellists were reminded not to use perfumed cosmetics and to avoid exposure to foods and / or fragrances at least 30 minutes before evaluation sessions. An eight-point intensity scale was used for scoring the different characteristics of the different treatments (Annexure B). Samples were scored using a category rating scale, with one (1) denoting the least intense condition and eight (8) denoting the most intense condition.

Evaluations were performed in individual sensory booths. Samples were evaluated under red light conditions to mask colour differences. The sensory analysis facility used, is constructed with all the elements necessary for an efficient sensory program and is constructed according to ASTM design guidelines for sensory facilities. The analyses were conducted over an 8-day period (excluding training) and samples were randomly assigned from all treatments and were

evaluated in three sessions (25 minutes apart) per day. All treatments were served on a blind random basis to the trained panellists under red light conditions. Carrot rings and water at room temperature were served in between evaluation sessions as palate cleanser.

Preparation of sensory samples

Mutton

The leg cuts of mutton were vacuum packed and frozen at -20°C and transported to the Meat Industry Centre of the ARC-Irene campus until the time of evaluation. The frozen legs were kept frozen and stored at -20°C (± 2°C) until the day of evaluation.

The cuts were thawed over a 48 hour period at 5°C before cooking. The cuts were prepared according to a moist heat cooking method and evaluated according to the American Meat Science Association and National Live Stock and Meat Board (Chicago, Illinois, 1995) research guidelines for the cookery and sensory evaluation measurements of fresh meat. The samples were cooked in identical ovens (Mielé ovens, model H217). 100 ml water (liquid) was added prior to the cooking of the meat. It was cooked in the oven at a temperature of 160 °C to an internal meat temperature of 75 °C (45 minutes per kilogram). A hand-held digital probe (model Kane-May 1012) was used to record the internal temperature at the geometric centre of the meat (American Meat Science Association, 1995:7-8). Cooking losses (thawing loss, drip loss, evaporation loss and fat mass) calculated from the total volume of fat according to the following: volume fat x 0.9 g / ml were measured as part of the standard procedure. After cooking, all samples rested at room temperature (centrally controlled at 22 °C), for 10 minutes. The *M. Semimembranosus* muscle was dissected and cut into cubes. The cubes measured 12 mm x 12 mm x 12 mm and each panellist received a standardized amount of each sample. Only the centre cubes were used and the dryer outsides were avoided. The meat cubes were wrapped in three-digit coded foil squares (90 x 90 mm) and presented (55°C) on pre-warmed plates to the panel. Samples were evaluated on an 8-point category scale with 1 = none; 8 = extreme. Eight repetitions were performed.

Grazing plants

The grazing plants were used during the training sessions of the panel in order to increase their acuity towards the nature the plants and enable them to detect any carry-over effect of the flavour of the different grazing plants to the mutton, if at all. The grazing plants were not evaluated scientifically. The tips and fine twigs of the grazing plants were removed and crushed. Approximately 2-4 g of each sample was placed into a large glass beaker and boiling water was added. The 'tea' was allowed to brew for about 5 minutes. It was then served to the panel in warmed 100ml glass beakers. The panel gave descriptive words for the different plants as listed in Table 2.

Fatty acid profiles

The thawing and cooking losses were recorded. The cooking losses, which included the stock and the fat were poured into one-litre glass cylinders that were labelled according to the sample codes, and left to separate into their different layers. The contents of the one-litre glass cylinders divided into two layers, i.e. stock (at the bottom of the cylinder) and fat (forming a layer on top). The volume of each layer was determined volumetrically after approximately 24 hours. Only the fat portion was used. The hard fat disc was removed from the stock, labelled and sent to the laboratory for the fatty acid analysis and CLA content.

The leaves and thin twigs of the grazing plants were sent to the laboratory for fatty acid analysis and CLA content.

Table 1: Lexicon for evaluation of lamb samples by the trained sensory panel

Aroma and Flavour	Definition / lexicon
Mutton	Aromatic associated with cooked lean muscle from mutton meat
Karoo bossie (grazing plants) – herbal	Mild aromatic associated with herbs such as rosemary or sage. Also slightly woody (aromatic associated with dry fresh cut wood). Contributes positively to the cooked flavour of the meat *Note: these aromas were not prominent, but rather mild and faint hints of these associations*
Karoo bossie (grazing plants) – musty, moldy	Farm like dusty, sandy and slightly musty, moldy or earthy aroma. Also an animal-like, barnyard-like or damp kraal manure aroma. Contributes negatively to the cooked flavour of the meat *Note: these aromas were not prominent, but rather mild and faint hints of these associations*
Fine or coarse texture	Refers to the texture of the muscle fibre. A fine texture refers to meat that is easy to chew and could disintegrate to some degree in the mouth, whereas a coarse texture has a rougher / stronger fibre, often associated with an older animal. A coarse texture can be tender
Overall tenderness	Chew sample with light chewing action
Overall juiciness	The amount of juice released following seven chews
Livery	Aromatic associated with cooked organ meat liver
Fatty	Fatty film that covers or coats the mouth and throat
Metallic	Flat flavour similar to metal coins e.g. canned tomato juice

Table 2: Descriptive words to describe the aroma and flavour profile of the bossie (grazing plant) samples

Grazing plants	Scientific name	Descriptive words
Silverkaroo	*Plnthus karrooicus*	Dusty, woody, damp, camomile
Skaapbossie	*Penzia spinescens*	Eucalyptus, bitter
Kapokbossie	*Eriocephalus ericoides*	Woody, bitter, eucalyptus, lavender, minty
Rivierganna	*Salsola glabrescens*	Dusty, sandy, soapy, woody, damp / musty

Ankerkaroo	*Pentzia incana*	Sage-like, eucalyptus, lavender, bitter
Perdebos	*Pieronia glauca / rosenia humilis*	Sage-like, lavender, camomile

STATISTICAL ANALYSIS

The quantitative descriptive data obtained from the sensory panel were entered on a spreadsheet using Microsoft Excel (2000). Data were statistically analysed by the ARC-Biometry Unit using the GenStat for Windows (2000) statistical computer program.

A multivariate analysis technique namely Principal Component Analysis (PCA) was applied to the full data set to reduce a large set of variates into a smaller set, which explained most of the variations in the entire data set (Shaw, Moshonas, Buslig, Barros & Widmer, 1999: 1951). Subsequently, a 2-way ANOVA was performed with breed and region as the main effects. Based on these results (Table 3), sensory data was combined per region and ANOVA (Table 4) plus PCA (Figures1 & 2) were performed on the latter. The F-probability for each attribute as well as the standard error of means (SEM) was recorded (Genstats, 2003; Snedecor & Cochran, 1980: 234-35).

Results

Sensory evaluation

The 2-way ANOVA that was performed with breed and region as the main effects, indicated no significant differences between the Merino and Dorper breeds (Table 3). The ANOVA of the combined sensory data per region indicated significant differences between the different regions (Table 4). Significant differences were found in the mutton aroma and flavour, which was most intense in the mutton from De Aar, Free State and Carnarvon. The musty aroma and flavour differed significantly between the different mutton samples. Carnarvon, Kalahari and Namibia were most intense in the musty aroma and mutton from Namibia had the most intense musty flavour. The samples differed slightly in textural attributes. Mutton from De Aar had the most course texture and mutton from Namibia, Free State and Carnarvon were found to be most tender**.**

It can be concluded that grazing plants from the Karoo and Karoo-like regions appear to impart herbal and musty flavour attributes to mutton meat from sheep breeds of these regions. The herbal attribute was found to contribute positively to the cooked flavour of the meat and the musty flavour attribute contributed negatively to the cooked flavour of the meat.

Table 3: Results of 2-way ANOVA with breed and region as the main effects

Attribute	Race			Region[1]				Interaction of region and race						
	p-value	Dorper	Merino	p-value	De Aar	Carnarvon	Free state	p-value of interaction	Dorper			Merino		
AROMA									DeAar	Car	Free	DeAar	Car	Free
Mutton	0.314	5.55	5.66	0.124	5.76	5.49	5.58	0.361	5.6	5.4	5.6	5.9	5.6	5.54
Herby	0.62	2.03	2.14	0.372	2.13	2.03	2.09	0.985	2.08	1.96	2.04	2.18	2.09	2.15
Musty	0.380	2.04	1.093	0.140	1.88	2.16	1.91	0.304	1.98	2.31	1.83	1.78	2.01	1.99
TEXTURE														
Texture	0.012	4.62	4.82	<0.001	4.96^{a}	4.56^{b}	4.65^{b}	0.221	4.9^{a}	4.5^{c}	4.45^{c}	5.0^{a}	4.63^{bc}	4.82^{ab}
Tenderness	0.687	4.92^{a}	4.85^{a}	0.009	4.54^{b}	5.01^{a}	5.12^{a}	0.159	4.59^{b}	4.85^{ab}	5.31^{a}	4.49^{b}	5.18^{a}	4.9^{ab}
Juiciness	0.797	4.4	4.37	0.559	4.33	4.48	4.35	0.289	4.48	4.44	4.29	4.18	4.51	4.42
FLAVOUR														
Mutton	0.385	5.379	5.45	0.270	5.49	5.33	5.42	0.597	5.4	5.29	5.44	5.58	5.38	5.4
Herby	0.107	1.896	1.996	0.399	1.981	1.887	1.969	0.506	1.98	1.84	1.88	1.99	1.94	2.06
Musty	0.507	1.767	1.71	0.318	1.65	1.812	1.75	0.179	1.74	1.9	1.66	1.56	1.73	1.84
Livery	0.223	1.363	1.285	0.256	1.25	1.35	1.37	0.625	1.33	1.35	1.41	1.18	1.35	1.33
Metallic	0.131	1.23	1.17	0.646	1.19	1.18	1.22	0.468	1.19	1.24	1.25	1.19	1.13	1.19
Fatty	0.301	1.84	1.89	0.919	1.85	1.87	1.88	0.729	1.85	1.84	1.83	1.85	1.9	1.93

[1]Kalahari and Namibia not included as Merino was not sampled from these regions

Table 4: Results of different regions

	p-value	SE	cv%	De Aar	Carnarvon	Kalahari	Namibia	Free State
AROMA								
Mutton	0.003	0.961	17.34	5.76^{a}	5.49^{bc}	5.38^{bc}	5.30^{c}	5.58^{ab}
Herby	0.559	0.898	43.73	2.13	2.03	1.99	1.95	2.09
Musty	0.022	0.974	48.19	1.88^{c}	2.16^{a}	2.15^{ab}	2.13^{abc}	1.91^{bc}
TEXTURE								
Texture	<0.001	0.982	21.07	4.96^{a}	4.56^{b}	4.48^{b}	4.48^{b}	4.65^{b}
Tenderness	<0.001	1.27	25.88	4.54^{c}	5.01^{ab}	4.70^{bc}	5.25^{a}	5.11^{a}
Juiciness	0.321	0.984	22.31	4.33	4.48	4.58	4.43	4.35
FLAVOUR								
Mutton	0.019	0.757	14.10	5.49^{a}	5.33^{abc}	5.28^{bc}	5.18^{c}	5.42^{ab}
Herby	0.452	0.858	44.77	1.98	1.89	1.88	1.79	1.97
Musty	0.013	0.887	49.60	1.65^{b}	1.81^{b}	1.80^{b}	2.08^{a}	1.75^{b}
Liver	<0.001	0.516	37.17	1.25^{c}	1.35^{bc}	1.31^{bc}	1.55^{a}	1.37^{b}
Metallic	0.276	0.410	34.09	1.19	1.18	1.16	1.29	1.22
Fatty	0.872	0.849	45.15	1.85	1.87	1.98	1.89	1.88

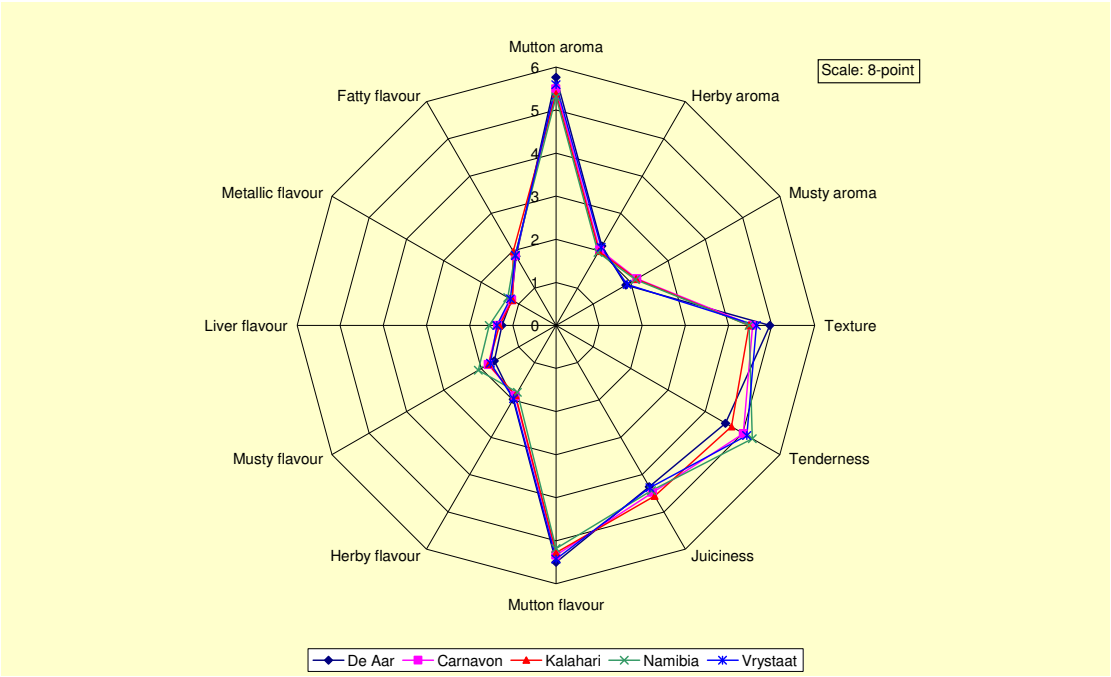

Figure 1: Spider graph of mean values of each attribute per region

Principal Component Analysis

PCA was performed to illustrate graphically (Figures 1 and 2) the correlation ratings given to the different descriptors. In PCA, all attributes were taken and it was applied on the mean values of each individual attribute per mutton sample as obtained from sensory analysis (aroma, texture and flavour).

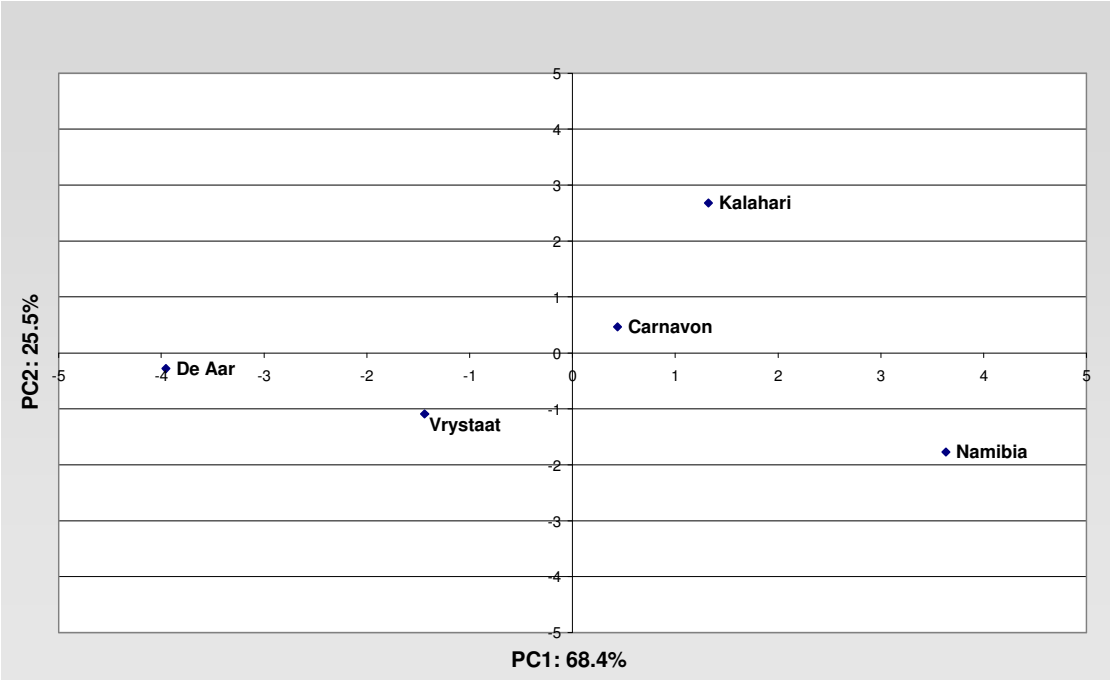

Figure 2: Graphical representation of the position of each mutton sample in relation to the PC-scores of mutton sample

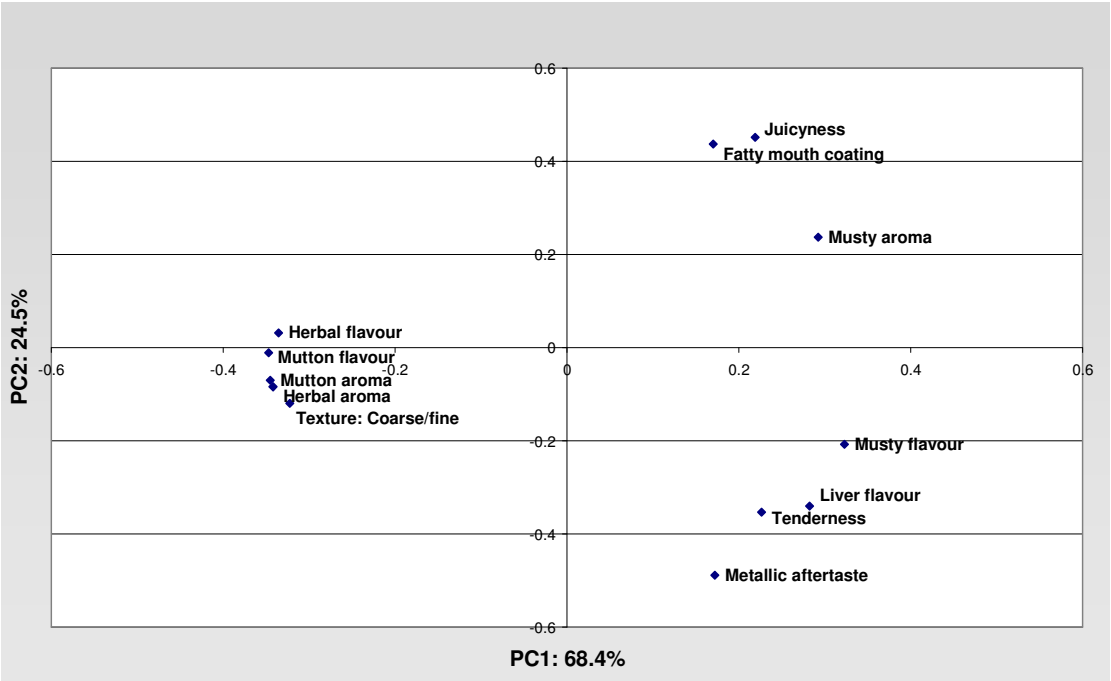

Figure 3: Graphical representation of the main attributes identified in the PCA that discriminated between the mutton samples

The PCA (Figures 1 & 2) explained 93 % of the total variation in the data. PC1 (68.4 %) was characterized with mutton flavour (r = -0.994), mutton aroma (r = -0.989), herbal aroma

(r = -0.980), herbal flavour (r = -0.961) and a coarse or fine texture (r = -0.924) attributes with negative loadings. PC1 was further characterized with a musty flavour (r = +0.924), musty aroma (r = 0.837) and livery (r = +0.809) flavour attributes with positive loadings. PC2 (24.5 %) was characterized with overall juiciness (r = +0.774) and fatty mouth coating (r= 0.750) attributes with positive loadings and metallic aftertaste (r = -0.838) with a negative loading. Mutton from the De Aar and Namibia contrasted each other the strongest in the PCA. Mutton from the De Aar region was most intense in the herbal component, although not significantly so, and had a slightly coarser texture that was not very tender, whereas mutton from the Namibia region was most intense in the musty flavour component with a slightly more tender texture. Mutton from the Carnarvon and Kalahari regions, which are situated in the heart of the Karoo, differed only slightly from mutton from Namibia and mutton from De Aar regions, respectively. However, these differences were not very distinct. The mutton from Carnarvon and Kalahari had a fairly intense mutton aroma and flavour and both the herbal and musty attributes were present in the meat. When comparing each region with one another, slight differences were found on the mutton aroma and flavour, musty flavour and livery flavour. Some textural differences were found between the breeds and regions.

Conclusion

Mutton from the Karoo region (Carnarvon, De Aar and Kalahari) has definite flavour characteristics present in the meat which can only be due to grazing plants in these areas that are consumed by sheep. However, this was not significantly different to mutton from adjacent Free State and Namibia regions respectively.

FATTY ACIDS AND CLA CONTENT

Mutton fat

The PCA explained 85.7 % of the total variation in the data refer figures (Figures 4 & 5). The first principal component explained 48.6 % of the variation in the data. The fatty acids with the highest positive correlations were: total mono unsaturated fatty (r = +0.963), C18:1n9c (r = +0.900) and total *cis* fatty acids (r = +0.880). CL16:0 (r = -0.944), total saturated fat (r = -0.935), total poly unsaturated fatty acids (r = -0.863) had the highest negative correlation in PC1.

PC 2 explained 37.2 % of the total variation in the data. The fatty acids with the highest negative correlations were C15:1 (r = -0.989), total *trans* fatty acids r = -0.970), C18:2c9t11 (r = -0.894) and C15:0 (r = 0.875).

Bossies

The PCA explained 84.29 % of the total variation in the data (refer Figures 6 & 7). The first principal component explained 53.7 % of the variation in the data. The fatty acids with the highest correlations coefficients were C23:0 (r = 0.884) and C22:0 (r = 0.815), which was the highest in Rivierganna and Silverkaroo. The fatty acids with the highest negative correlation coefficients were C16:0 (r=-0.990), total *trans* fats (r = -0.987), C18:1n9t = (r = -0.987), total saturated fat (r= -0.961), C12:0 (r = -0.910), C10:0 (r = -0.908), mono-unsaturated fatty acids (r = -0.899), C 18:1n9c (r=-0.897), C14:0 (r= -0.860), C18:2nc9t11 (r = -0.829) and C18:0 (r = -0. 827). These fatty acids were highest in Ankerkaroo and Perdebos.

PC2 explained 30.6 % of the total variation in the data. The fatty acids with the highest positive correlation coefficients were C18:3n3 (r = 0.923), poly unsaturated fatty acids (r = 0.874) and C20:5n3 (r = 0.817). C17:1 (r = -0.869) and C8:0 (r = -0.815) had the highest negative correlation coefficients. These fatty acids were the highest in Perdebos.

FATTY ACID ANALYSIS AND CLA CONTENT

Table 6: Summary of total saturated fatty acids, mono-unsaturated, poly-unsaturated, *trans*- and *cis*-fatty acids, omega-3 and omega-6 fatty acids and CLA content of Karoo mutton fat samples

Fatty acid analysis	Total	p-value	Dorper De Aar	Dorper Carnarvon	Dorper Kalahari	Dorper Namibia	Dorper Vrystaat	Merino De Aar	Merino Carnarvon	Merino
Saturated fatty acids	**52.43**	0.001	50.28^{c}	52.58^{b}	52.73^{b}	51.99^{b}	52.07^{b}	58.13^{a}	49.68^{c}	51.96^{b}
Mono-unsaturated fatty acids	**43.87**	0.001	45.99^{a}	43.21^{c}	44.16^{b}	44.37^{b}	44.70^{b}	37.28^{d}	47.21^{a}	44.03^{b}
of which *trans*-fatty acids	*2.572*	0.001	2.209^{e}	2.365^{c}	2.103^{f}	3.058^{b}	2.322^{d}	2.313^{d}	2.383^{e}	3.826^{a}
of which *cis*-fatty acids	*37.54*	0.001	40.53^{a}	36.81^{c}	38.62^{b}	36.97^{c}	38.53^{b}	31.98^{d}	40.68^{a}	36.22^{c}
Poly-unsaturated fatty acids	**3.073**	0.001	3.724^{c}	4.205^{b}	3.111^{d}	3.643^{c}	3.226^{d}	4.591^{a}	3.117^{d}	4.007^{b}
of which *trans*-fatty acids	*0.462*	0.001	0.471^{cd}	0.485^{bc}	0.423^{d}	0.453^{cd}	0.522^{b}	0.433^{d}	0.362^{e}	0.550^{a}
of which *cis*-fatty acids	*1.869*	0.001	1.858^{cd}	2.107^{b}	1.583^{ef}	1.828^{d}	1.481^{f}	2.426^{a}	1.675^{e}	1.992^{bc}
Total *trans*-fatty acids	**3.034**									
Total *cis*-fatty acids	**39.41**									
Omega-6 fatty acids	**0.387**									
Omega-3 fatty acids	**0.983**									
CLA content (C28:2c9t11)	**0.5608**	0.001	0.429^{f}	0.521^{d}	0.505^{de}	0.655^{b}	0.541^{c}	0.394^{g}	0.492^{e}	0.952^{a}

Table 6: Summary of total saturated fatty acids, mono-unsaturated, poly-unsaturated, *trans*- and *cis*-fatty acids, omega-3 and omega-6 fatty acids and CLA content of Karoo bossies samples

Fatty acid analysis	Total	p-value	Silwerkaroo	Skaapbossie	Kapokbossie	Rivierganna	Ankerkaroo	Perdebos
Saturated fatty acids	**0.691**	<0.001	0.450^{e}	0.744^{c}	0.617^{d}	0.406^{f}	0.870^{b}	1.058^{a}
Mono-unsaturated fatty acids	**0.472**	<0.001	0.317^{e}	0.415^{d}	0.462^{c}	0.320^{e}	0.756^{a}	0.570^{b}
of which *trans*-fatty acids	*0.008*	0.116	0.003	0.009	0.007	0.000	0.015	0.013
of which *cis*-fatty acids	*0.437*	<0.001	0.296^{e}	0.377^{d}	0.410^{c}	0.304^{e}	0.696^{a}	0.539^{b}
Poly-unsaturated fatty acids	**0.5**	<0.001	0.384^{e}	0.631^{b}	0.421^{d}	0.515^{c}	0.845^{a}	0.204^{f}
of which *cis*-fatty acids	*0.386*	<0.001	0.303^{c}	0.421^{b}	0.315^{c}	0.427^{b}	0.681^{a}	0.169^{d}
Total *trans*-fatty acids	**0.008**		0.003	0.009	0.007	0.000	0.015	0.013
Total *cis*-fatty acids	**0.823**		0.599^{e}	0.798^{b}	0.725^{cd}	0.731^{c}	1.376^{a}	0.707^{d}
Omega-6 fatty acids	**0.387**							
Omega-3 fatty acids	**0.110**							
CLA content (C18:2c9t11	**0.0008**	0.006	0.001	0.000	0.001	0.000	0.002	0.002

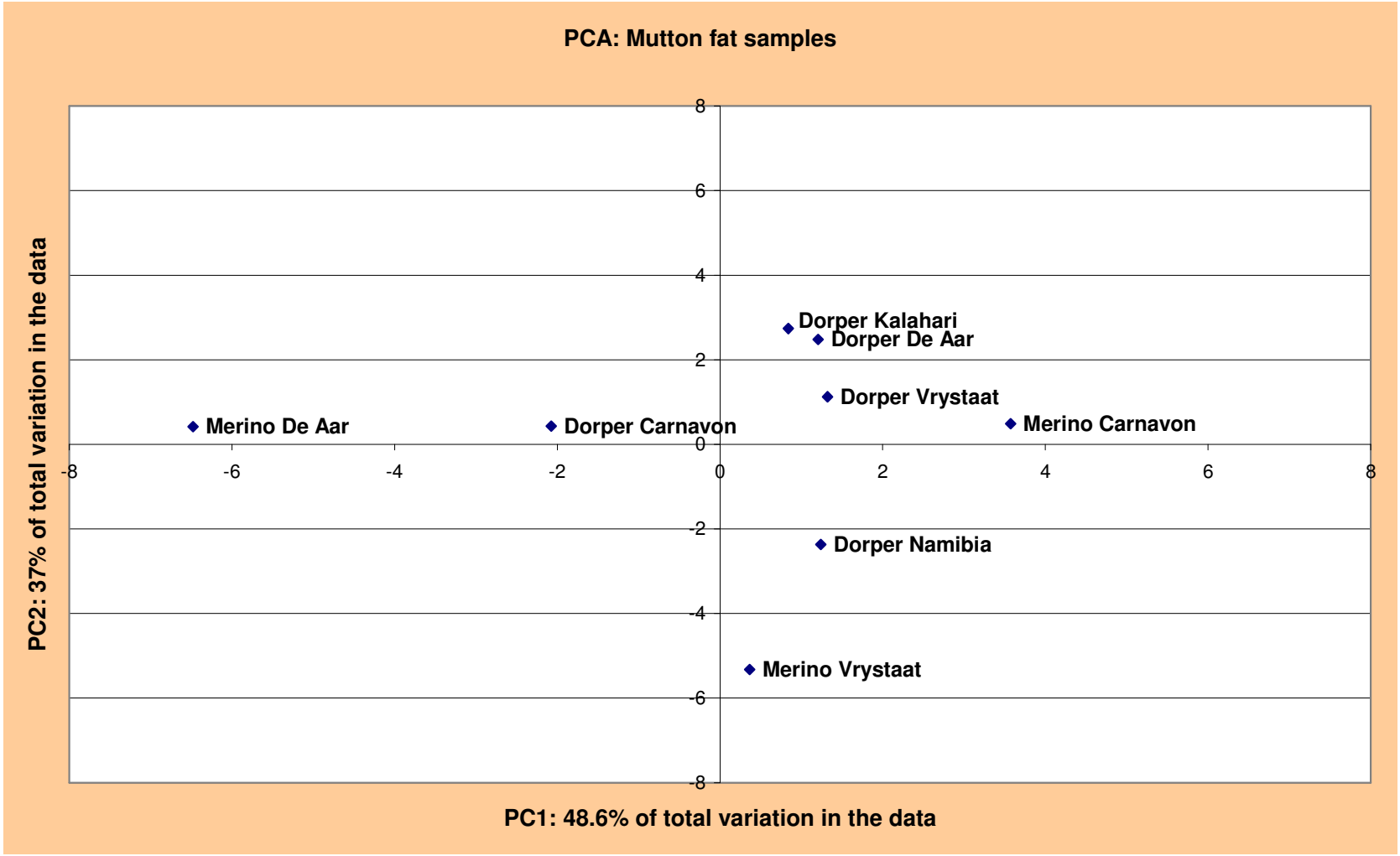

Figure 4: Graphical representation of the position of each mutton fat sample in relation to the PC-scores of mutton fat sample

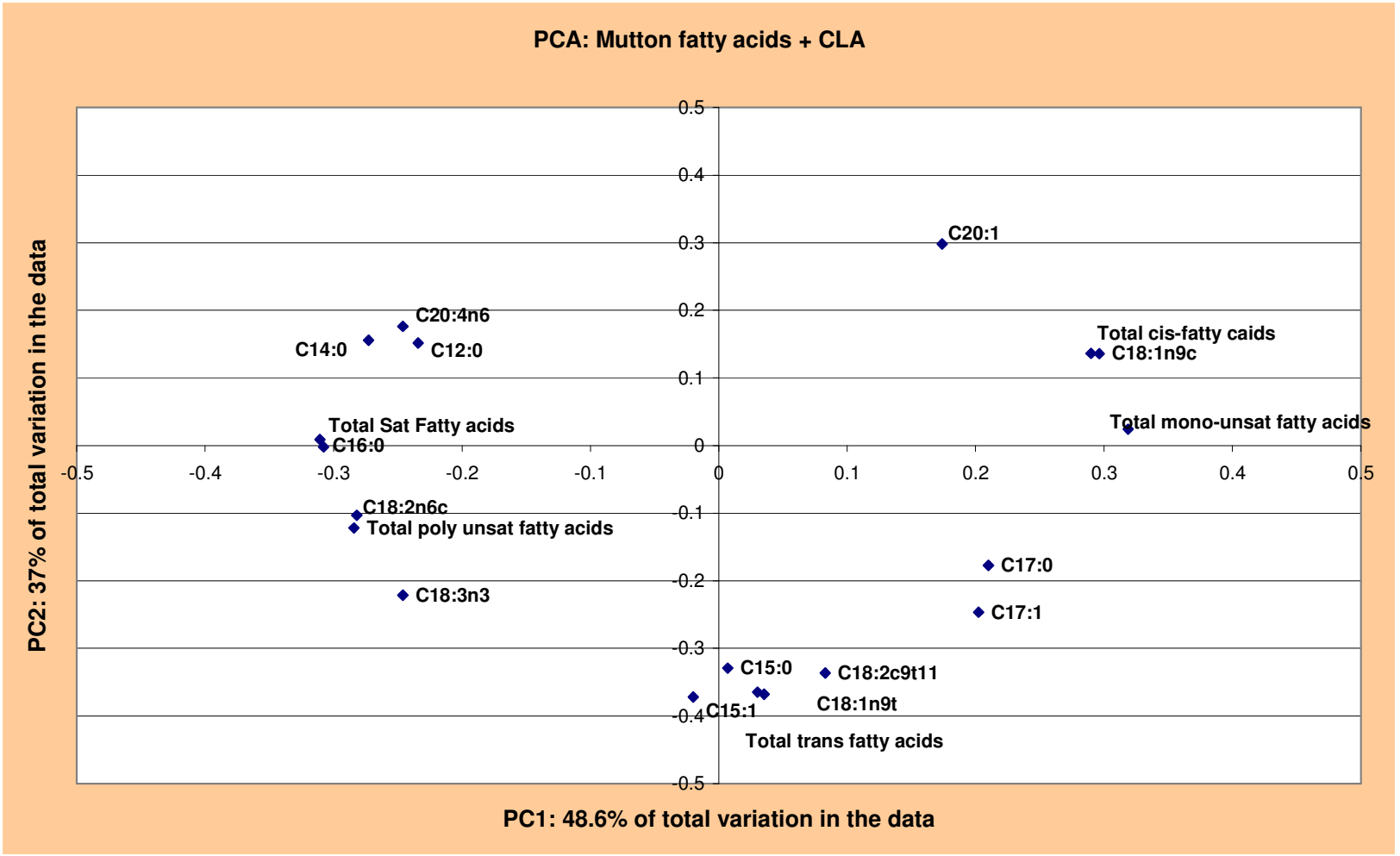

Figure 5: Graphical representation of the main fatty acids identified in the PCA that discriminated between the mutton fat samples

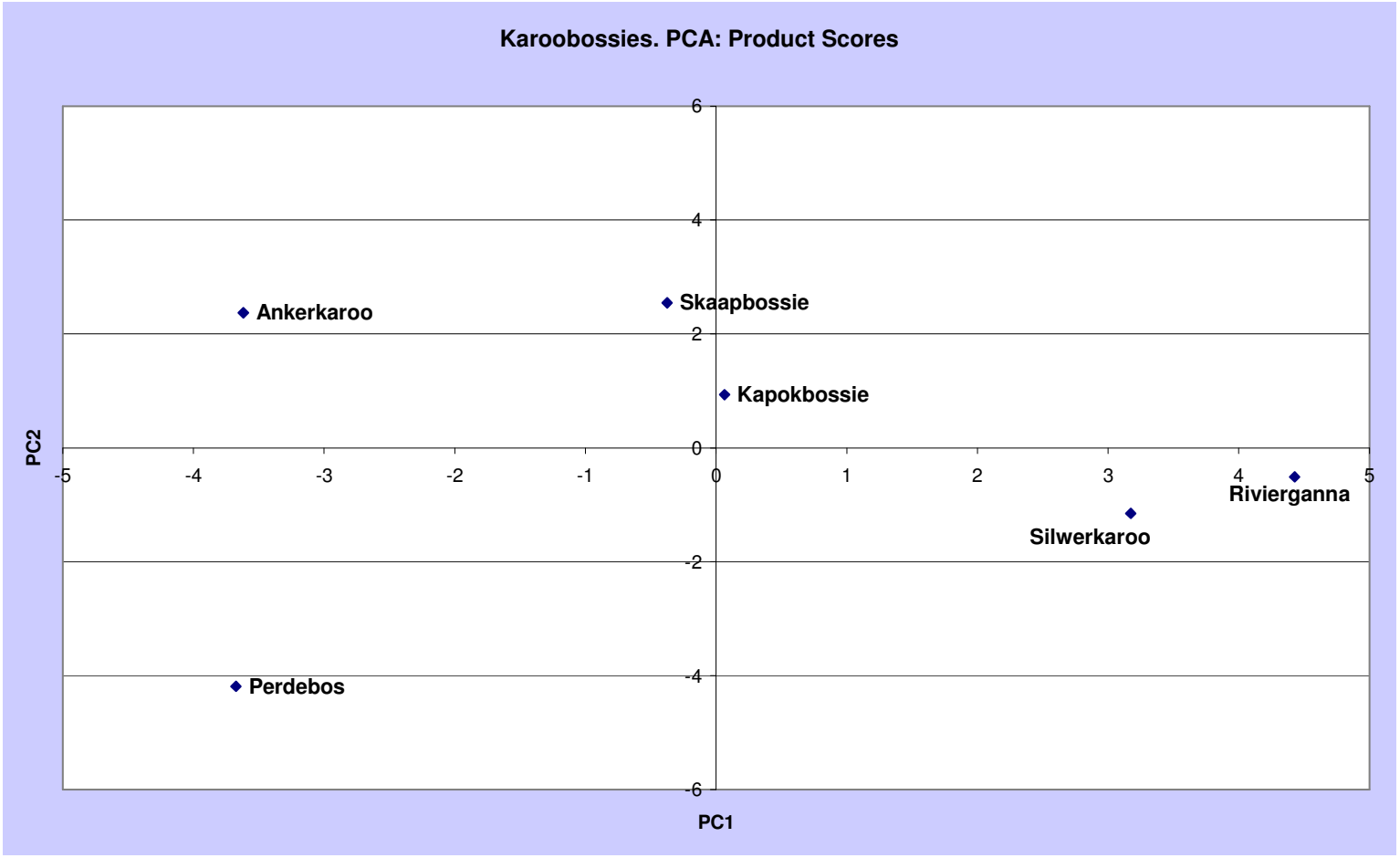

Figure 6: Graphical representation of the position of each bossie sample in relation to the PC-scores of bossie sample

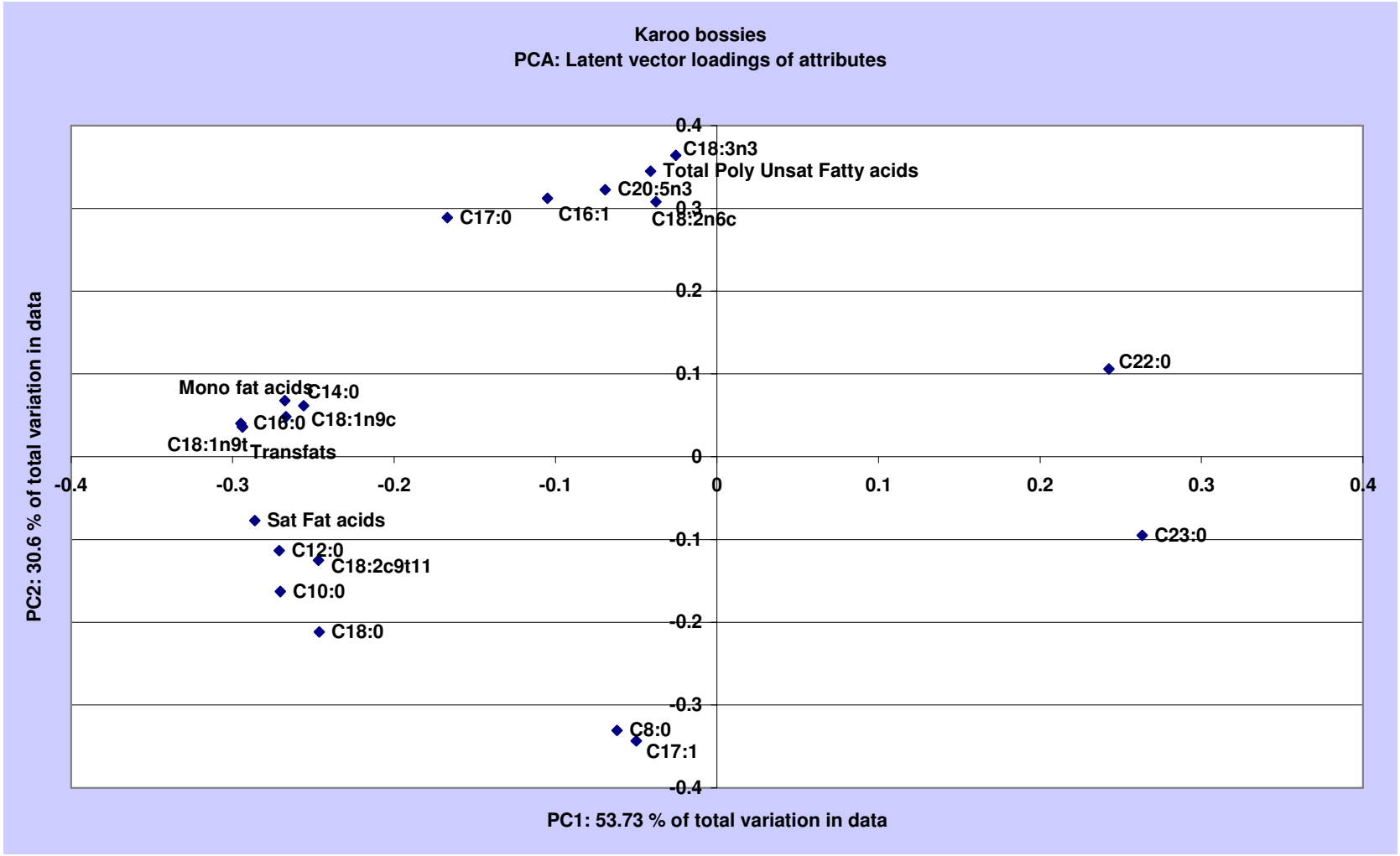

Figure 7: Graphical representation of the main fatty acids identified in the PCA that discriminated between the bossie samples

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ANNEXURE 1: Evaluation form

SENSORY ANALYSIS OF LAMB **4 - 17 July 2007**

Name:…… **Date:……**

Please evaluate the following samples of lamb for the designated characteristics.
NOTE THE CODE OF EACH SAMPLE – and fill in the correct column

Characteristics	**Rating scale**				
AROMA INTENTSITY					
1. MUTTON Take a few short sniffs when opening the foil containing the sample and also slightly pull fibres of the meat in order to smell the meat	1 = Extremely bland / weak 2 = Very bland / weak 3 = Fairly bland / weak 4 = Slightly bland / weak 5 = Slightly intense / strong 6 = Fairly intense / strong 7 = Very intense / strong 8 = Extremely intense / strong				
2. BOSSIE (Herbal/woody) Positive contribution to the flavour of the lamb	1 = Extremely bland / weak 2 = Very bland / weak 3 = Fairly bland / weak 4 = Slightly bland / weak 5 = Slightly intense / weak 6 = Fairly intense / weak 7 = Very intense / strong 8 = Extremely intense / strong				
3. BOSSIE (Musty, moldy, farm-like) Negative contribution to the flavour of the lamb	1 = Extremely bland / weak 2 = Very bland / weak 3 = Fairly bland / weak 4 = Slightly bland / weak 5 = Slightly intense / weak 6 = Fairly intense / weak 7 = Very intense / strong 8 = Extremely intense / strong				
TEXTURE & APPEARANCE					
7. FINE OF COARSE TEXTURE	1 = Extremely fine 2 = Very fine 3 = Fairly fine 4 = Slightly fine 5 = Slightly coarse 6 = Fairly coarse 7 = Very coarse 8 = Extremely coarse				
5. OVERALL TENDERNESS Chew sample with a light chewing action	1 = Extremely tough 2 = Very tough 3 = Fairly tough 4 = Slightly tough 5 = Slightly tender 6 = Fairly tender 7 = Very tender 8 = Extremely tender				
6. OVERALL JUICINESS The impression of juiciness that you form as you start chewing	1 = Extremely dry 2 = Very dry 3 = Fairly dry 4 = Slightly dry 5 = Slightly juicy 6 = Fairly juicy 7 = Very juicy 8 = Extremely juicy				

FLAVOUR					
8. OVERALL MUTTON FLAVOUR	1 = Extremely bland 2 = Very bland 3 = Fairly bland 4 = Slightly bland 5 = Slightly intense 6 = Fairly intense 7 = Very intense 8 = Extremely intense				
9.KAROO BOSSIE - Herbal/woody Positive contribution to the flavour of the lamb	1 = Extremely bland / weak 2 = Very bland / weak 3 = Fairly bland / weak 4 = Slightly bland / weak 5 = Slightly intense / weak 6 = Fairly intense / weak 7 = Very intense / strong 8 = Extremely intense / strong				
10. KAROO BOSSIE - Musty, moldy, farm-like Negative contribution to the flavour of the lamb	1 = Extremely bland / weak 2 = Very bland / weak 3 = Fairly bland / weak 4 = Slightly bland / weak 5 = Slightly intense / weak 6 = Fairly intense / weak 7 = Very intense / strong 8 = Extremely intense / strong				
11. LIVER FLAVOUR	1 = Extremely bland 2 = Very bland 3 = Fairly bland 4 = Slightly bland 5 = Slightly intense 6 = Fairly intense 7 = Very intense 8 = Extremely intense				
12. METALLIC	1 = Extremely bland 2 = Very bland 3 = Fairly bland 4 = Slightly bland 5 = Slightly intense 6 = Fairly intense 7 = Very intense 8 = Extremely intense				
13. FATTY / OILY FLAVOUR OR MOUTH COATING	1 = Extremely little coating 2 = Very little coating 3 = Fairly little coating 4 = Slightly little coating 5 = Slight fatty coating 6 = Fair fatty coating 7 = Very definite fatty coating 8 = Extreme fatty coating				

Comments……

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ANNEXURE 2

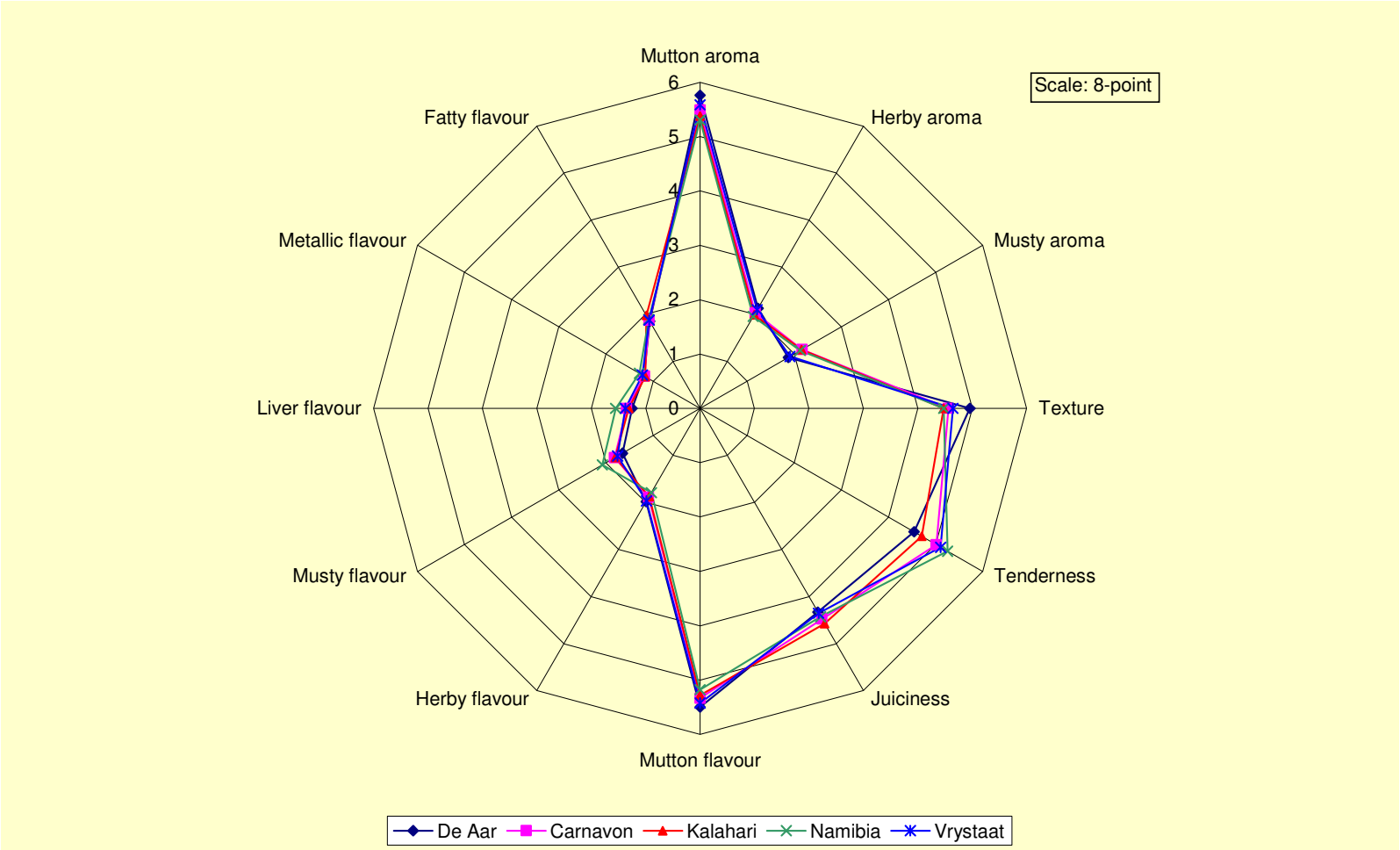

Figure 1: Spider graph of mean values for the different attributes per region

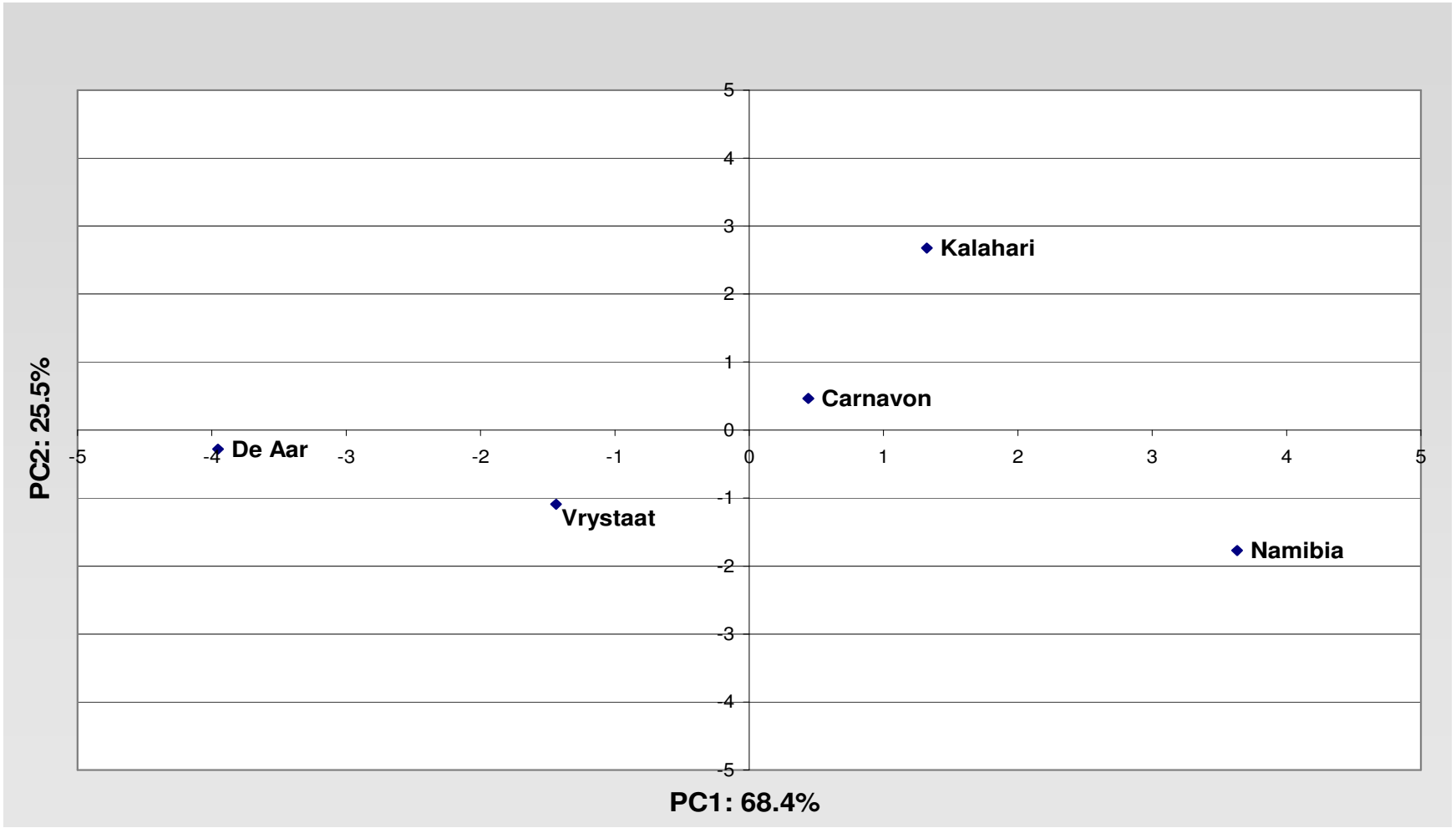

Figure 2: Graphical representation of the position of each mutton sample in relation to the PC-scores of mutton sample

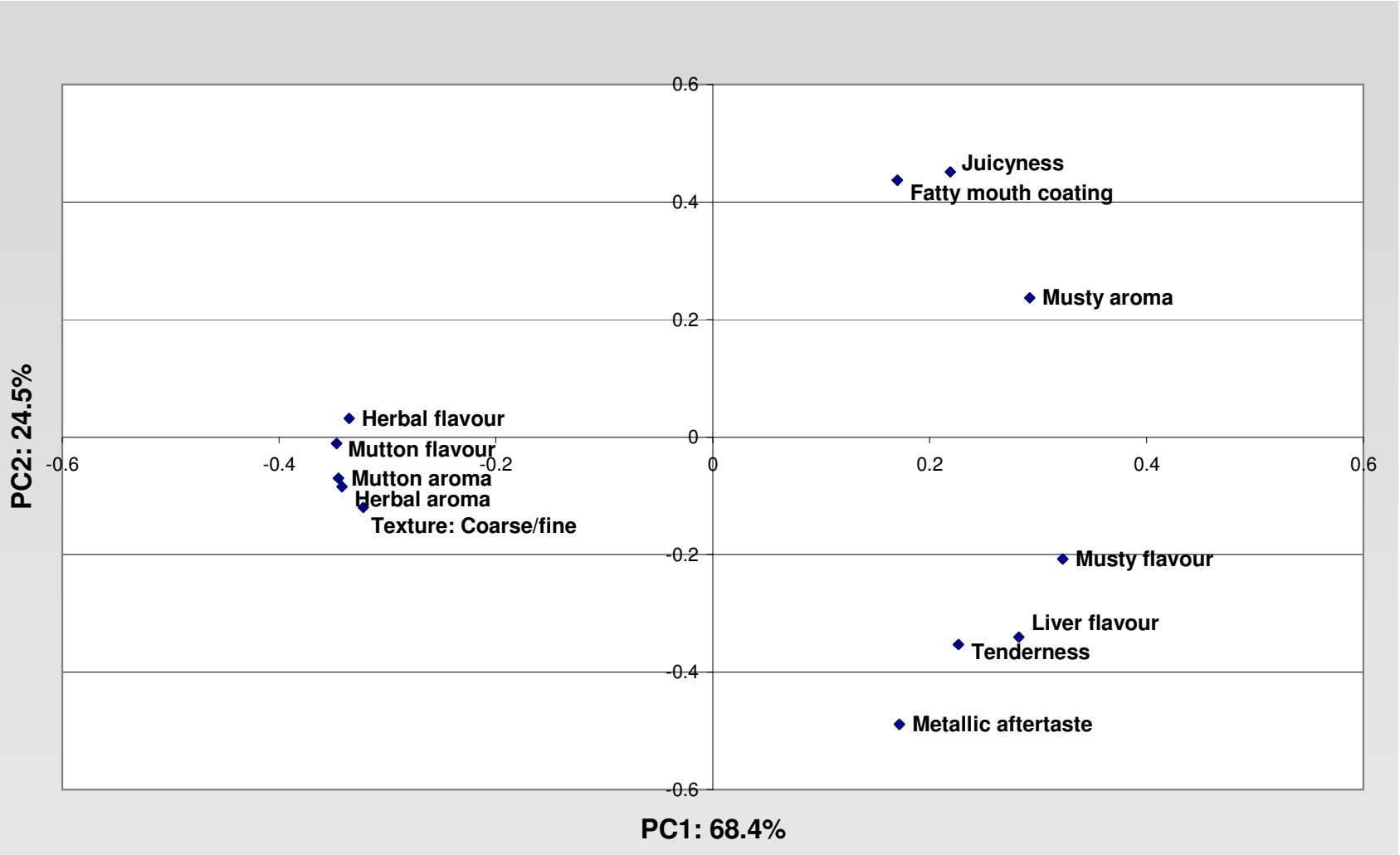

Figure 3: Graphical presentation of the main attributes identified in the PCA that discriminated between the mutton samples