A Comparative Review of the Beef Carcass Classification Systems of Selected African Countries with the Red Meat Classification System Found in the European Union

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Authors' contributions

This work was carried out in collaboration among all authors. Author BND designed the study, performed the literature searches and wrote the first draft of the manuscript. Authors MTM and THG managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

Article Information

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ABSTRACT

Beef carcass classification represents an assurance to the consumer that the meat conforms to established set of official standards according to consumer demands and expectations. Most beef carcass grading systems combine both the grades for quality (carcass maturity, fatness, conformation, carcass defects) and quantity (expected yield). However, there is scarcity of documented information on the existing beef classification systems among some African countries. The main purpose of this review is to highlight the heterogeneity of the existing beef grading systems in selected African countries. The criteria used in beef carcass classification systems of these African countries were examined in the present study, and compared with the European Union red meat classification system. The results of this review indicated lack of uniformity in beef carcass classification systems among the selected African countries. In addition, the results show that at the moment some African countries have not adopted an objective system of beef carcass

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grading. Therefore, the existing red meat classification system using non-objective visual assessment of beef carcasses could be biased. The use of objective quality indices/attributes is recommended as a form of an improvement that will be aligned with consumer expectations.

1. INTRODUCTION

Carcass classification is a critical component of livestock production that affects price determination and is intended to meet consumer expectations. The classification or grading of carcasses is largely dependent upon the description of carcasses using well defined anatomic features that are of major importance for the meat industry, retailers and consumers [1]. The main objective of this review paper is to provide an overview of the existing heterogeneity of beef grading systems in some African countries, including Swaziland, and thereby, highlight the status quo in beef grading systems on the African context. Consequently, this review paper will point out the urgent need to address developmental resources on beef carcass grading in the livestock industry.

2. BEEF CARCASS CLASSIFICATION IN SWAZILAND

Beef classification systems in some countries are mainly emphasized on carcass yield. In Swaziland, the documented carcass grading or classification system utilised at the SG1 beef export slaughterhouse has been in force since 1994. This grading system is an attempt to adopt a system that takes into consideration both the carcass yield and quality [2,3] characteristics. The majority of the countries regulate the marketing and sale of beef by observing grading criteria of cattle carcasses at the abattoir and by classifying the carcasses. This classification is at times optional, may sometimes suggest a market demand for a particular animal's attribute and therefore determine the price for the producer [4] The beef classification system used at the beef export slaughterhouse, uses the following quality grades Super(S), Prime (Pr), Good Average Quality (GAQ), Fair Average Quality (FAQ), Compound (Co - broken mouth, degree of bruising and or older carcasses). Carcasses of bulls are not quality graded and that of bullocks are graded separately from steers. The Super grade is higher than the Prime grade. Carcass maturity in terms of age plays a significant role in differentiating between the grades for the GAQ, FAQ and the compound carcass. Maturity is qualitatively determined by evaluating the size,

shape and ossification of the bones and cartilages - especially the split chine bones of the vertebral column, the colour of lean flesh meat and by means of the number of erupted incisors. The size and shape of rib bones, in old animals becomes wider and flatter with less blood. In the most older – aged cattle carcasses, the colour of skeletal muscle becomes darker with a coarser texture [2]. Raw meat properties like water binding, texture, juiciness, flavour, colour, lipid stability and microorganism growth are considered as important parameters in influencing perceptions of meat quality and immediate purchase decisions of specific meat products by consumers [5].

One of the noted drawbacks of the Swaziland carcass grading system is the degree of subjectivity associated with the classification, it is not be easy to monitor or verify correctness once a grade is assigned to a carcass [2]. In many countries with access to the EU, the descriptive system of visual scoring of conformation, carcass mass, age of cattle when exporting beef meat to the European market is mandatory in order to comply with the EUROP grid method of carcass classification [6].

Table 1 shows the beef carcass classification into the five groups based on the carcass age as indicated by the incisors. The system does not take into consideration the other carcass factors such as bones, cartilage and the meat colour of the carcass.

Table 1. SG1 carcass grading system for cattle used in Swaziland [2]

Carcass grading	Dentition of the animal
Super(S)	0-1 permanent incisors
Prime(P)	1-2 permanent incisors
Good Average Quality(GAQ)	3-6 permanent incisors
Fair Average Quality (FAQ)	>6 permanent incisors
Compound (Co)	Worn out permanent incisors/Broken mouth

The 2014 Audit mission number 7245 sanctioned by the European Commission, concluded that the official beef carcass meat control carried out at

the SG1 beef export establishment were in general satisfactory and well documented [7]. A similar view on the production of fresh bovine meat and the certification procedures practiced in the country was upheld by the OIE audit mission [8].

3. BEEF CARCASS CLASSIFICATION IN BOTSWANA

In Botswana, the grading of carcasses is regulated by the Ministry of Agriculture. This official control ensures that there is an independent process that is used as the basis for rewarding cattle farmers that produce animals that best adhere to market demands and expectations. The Botswana beef grading system provides a range of carcass types in the form of age, conformation, fat cover and primal sizes. The age of the animal at slaughter is taken into consideration and is largely based on the animal's dentition [9,10,11]. In addition, carcass classification is based on the level and evenness distribution of fat cover and the conformation or shape of the carcass. Ultimately, the system ends up with four grades, which are Premier Range (young animals up to 30 months), Super range (young animals up to 36 months), Blue range (older animals) and Red range (these are animals of any age with no carcass classification requirements [12].

According to the Botswana OIE-PVS Evaluation report for 2010, the audit mission concluded that according to Ante and Post mortem inspection and collection of meat safety and quality information, procedures were generally undertaken in conformity with international standards for exports premises and the majority of abattoirs produce meat suitable for distribution in national and local markets [13].

4. BEEF CARCASS CLASSIFICATION IN NAMIBIA

The Namibian classification of beef entails the visual appraisal of a carcass by describing characteristics, such as age/number of teeth, fatness, muscle conformation, sex and the carcass damage in terms of the severity of carcass bruising. Visual appraisal is used to judge the fatness or subcutaneous fat on beef. The naked eye is more accurate in detecting the localization of fat on a carcass than by measuring the fat thickness with an instrument [14,10]. It is critical to include fatness determination as a criterion in beef carcass grading since fatness determines the percentage of meat that can eventually be sold from a carcass, but fatness also protects a carcass against bacterial penetration and from losing moisture by drying out. At the same time, improved juiciness and flavour of beef is derived from carcasses with a high fat content. During the subcutaneous fat evaluating process, the carcass is divided into a hindquarter, middle section and a forequarter. Two thirds of the carcass must be covered by subcutaneous fat for obtaining a specific fat code [14,15,16].

The spread of subcutaneous fat around the beef carcass is visually assessed and given the following codes;: Code 0 for no fat, Code 3 for medium fat cover of 3.1 to 5.0 mm, Code 5 for over fat at 7.1 to 10.0 mm and Code 6 for excessively over fat at more than 10.0 mm. The damage or bruising normally associated with poor carcass handling, and carcass is graded as undamaged (Class 0), damaged to such an extent that, the fat to meat to bone ratio of such a carcass is slightly disturbed (Class 1), moderately disturbed (Class 2) severely disturbed (Class 3) and heavily bruised or severely damaged carcasses are penalized at abattoirs and farmers obtain less money because their meat cannot be exported [17].

The age and fatness play key role in classification of carcasses [15]. The abattoir identification code is also incorporated into the roller marking. This code contributes to the traceability of specific complaints regarding carcass dressing, classification, hygiene and inspection. The ink that is used in the roller marking should be consumer friendly and edible [15,18].

5. BEEF CARCASS CLASSIFICATION IN SOUTH AFRICA

The South African beef classification system appears to be similar in some respects to classification system of other African countries, since it is based on carcass traits such as bruising, subcutaneous fat, conformation, dentition and meat quality especially tenderness [19]. Tenderness appears to be one of the best attributes of the classification system, when compared to most grading systems that place major value on carcasses for commercial or pricing purposes [20]. Also, the South African classification system takes into account the young feedlot and the mature veld pasture animals. However, some authors state that this system also has its drawbacks. For example, it does not sufficiently address issues of correct

pre-slaughter and slaughter management, such as stress, weight, chilling rate, electrical stimulation, and post mortem aging of slaughter animals [17]. In addition, other researchers complained that the South African red meat classification system only allows classification of meat based on age and fat covering. Thus, there is a need for the existing system to be amended [21].

In terms of consumer perspectives of the South African red meat classification system, the various socio-economic subgroups have shown good grasp of red meat knowledge and product quality [22]. The key findings of the OIE evaluation mission reported that the process of registration, inspection, accreditation and auditing of all slaughter and food inspection facilities is quite effective. Regarding food safety regulation, authorisation and inspection of relevant establishments are undertaken in conformity with international standards for premises supplying the national and local markets [23].

6. BEEF CARCASS CLASSIFICATION IN ZIMBABWE

Beef carcass grading in Zimbabwe is similar to that of some European countries and combines fat cover, body conformation, gender and bruising with carcass maturity in order to determine the final classification [3,24]. The Prime, Choice, and Good or Select being the commercial grades. The standard grade carcasses are the utility types and the Cutter types being those carcass grades below the standard grades. The marbling is further classified into abundant, moderately abundant, slightly abundant, moderate, modest, small, slight, traces and practically devoid of marbling [3]. The carcass maturity is further graded into commercial, Utility and Cutter grades [4,25]. It is important to note that the government of Zimbabwe has undertaken plans to review the meat grading classification process in order to satisfy both the local and the export markets. The cold storage commission implements a carcass grading scheme to determine the producer pay-out price [26,27]. The beef classification system mainly relies on three carcass characteristics, namely the age (determined on the basis of the dental structure for young cattle and spinal ossification of more mature cattle); the Flesh cover (determined in terms of the relationship between carcass length and mass) and lastly the fat cover [26,3,28].

7. BEEF CARCASS CLASSIFICATION IN THE EUROPEAN UNION

Beef carcass Classification is required under European Union (EU) Regulations [29]. These regulations ensure the uniform classification of beef carcasses for the purposes of EU cattle price reporting. It is also intended to improve transparency in the marketing of beef carcasses for the benefit of all stakeholders of the industry. In the slaughterhouses, parameters such as state of nutrition, bruising, haemorrhage, discoloration, oedema, efficiency of bleeding, age and sex are examined in each carcass. Most of these conditions are undesirable since they reduce carcass quality, and saleability, but also storage quality of the meat [10,30]. Physiological leanness resulting from lack of feed and water should be differentiated from pathological leanness due to disease. The grading criteria ensure that only quality beef carcasses are sold as meat to consumers [31,32]. According to Codex Alimentarius, (1993) the responsibility for the production of safe and wholesome meat should be shared by industry and the controlling authority. Industry personnel should be involved in voluntary quality assurance systems and in monitoring of meat hygiene and the controlling authority is involved in the supervision and audit to ensure compliance with requirements. On the other hand, both industry and the controlling authority should participate in training and education programs.

The aim of the European Union (EU) beef carcass classification scheme is to ensure a common classification standard throughout the EU. The criteria for classification include carcass conformation denoted by letters showing the highest grade and the poorest grade, the degree of Fat cover denoted by numbers in order of increasing fatness, the sex category of the animal (young bull, bull, steer, cow, heifer) denoted by letters. Over 90% of the carcasses are classified by machine. Machine classification by Video Image Analysis (VIA) examines several parameters of the carcass and is objective [33]. Moreover, researchers found that it is possible to determine with high accuracy the muscle mass of the hind leg using spiral CT Scans, but on the other hand the implementation of automated image analysis procedures is sometimes restricted by the failure to analyse some of the images [34,35]. In small slaughterhouses classification of the remaining 10% beef carcases is carried out by departmental licenced

Table 2. VIA classification accuracy data Source [37]

Meat plant	VIA score for conformation grade	VIA score for fat class	Percentage (%) of carcasses dressed to specification
A	844	909	91.6
B	855	896	91.5
C	874	879	90.3
D	869	878	93.3
E	883	846	92.3
F	867	921	90.9
G	817	896	95.0

factory employees of the Department of Agriculture, Fisheries and Food (DAFF). In cases where the subjective manual classification system had been used, the supplier is allowed to appeal the decision of the classifier [25]. However, the accuracy of visual assessment of beef carcasses using the EUROP evaluation is alleged to be biased and with evaluator error [36]. Table 2 shows results of classification using Video Image Analysis (VIA).

Table 2. Shows how the VIA Score is used grading the carcasses. Legislative requirements (Commission Regulation (EC) 1249/2008) dictate a minimum score of 600. Accordingly, the above results of VIA Scores for Fat Class indicates how accurately the Visual Imaging Analysis equipment is capable of grading the carcasses. It is important to note that if the results from a check on a machine are unsatisfactory Department of Agriculture and Rural Development (DARD) requires the machine to be switched off and carcasses to be graded manually. The data from checks carried out when a machine is switched off are not included in the carcass inspection report. The slaughter houses using VIA are each responsible for the accuracy of the carcass classification in their business. The machine is designed, calibrated and checked regularly to ensure that the European Community (EC) Classification Standard is accurately applied across all categories of carcasses, animals aged 8 months to under 12 months, Young Bulls (<2 years), Mature Bulls, Steers, Cows and Heifers. DARD regularly completes analysis by category and even by grade to determine if levels of accuracy remain acceptable [37]. Processors are statutorily obliged to notify producers whether carcasses were classified by automatic or manual means. This is often shown on remittance advice notices as A for VIA classification and M for manual or human classification [34]

8. COMPARISON OF THE BEEF CLASSI-FICATION SYSTEMS BETWEEN THE AFRICAN COUNTRIES AND THE EU

The current beef carcass classification criteria in different African countries were compared with similar or related beef carcass classification systems within the continent in terms of content. The results of this comparison (Table 3) show that beef classification systems of the selected

Table 3. Comparison between Beef carcass classification systems in selected African countries and in the EU

Criteria	Swaziland	South Africa	Namibia	Botswana	Zimbabwe	E.U
Age/Dentition	+	+	+	+	+	+
Fatness						
-Location	-	+	+	+	-	+
-thickness (mm)	-	-	+	-	-	+
Muscle size/ Conformation	-	+	+	+	+	+
Bruising	+	+	+	+	+	+
Sex	+	+	+	+	+	+
Abattoir ID	+	+	+	+	+	+
Roller Marking/official stamp	+	+	+	+	+	+
Cold dress mass	+	+	+	+	+	+

Explanatory notes: +: Means the criteria is routinely practiced in beef carcass grading; -: Means the criteria is not routinely practised during beef carcass grading

African countries have certain similarities. However, it is noted that there is a need for some improvements of the classification systems in order to overcome the observed drawbacks of the existing beef classification systems.

In comparison to the European Union, this review shows that some of the African countries mentioned in this study do not routinely include fat cover, and machine classification of beef carcasses.

9. CONCLUSION

Therefore, it is recommended (1) to develop and implement grading specifications and or regulations for beef carcass in order to ensure the monitoring and enforcement of common classification standards in some African countries including Swaziland, (2) to introduce objective classification methods of beef carcasses by machine, (3) that the competent veterinary authorities develop and introduce guidelines for the licensing of beef carcass graders in their respective countries, and (4) to improve the local beef classification by introducing and including meat quality properties (tenderness, taste, colour and intramuscular fat, this could be of significance in satisfying the demand of consumers in the EU beef export market.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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