Morphometric characteristics and consumer acceptability of meat from Potchefstroom Koekoek, Black Australorp, Venda and Ovambo chickens

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Declaration

I, **Mandisa Bongeka Acquilla**, vow that this dissertation has not been submitted to any University and that it is my original work conducted under the supervision of Prof. M. Chimonyo. All assistance towards the production of this work and all the references contained herein have been duly accredited.

Mandisa Bongeka Acquilla **Date**

Approved as to style and content by:

Prof. Chimonyo (Supervisor)

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Abstract

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Indigenous chicken production receives little institutional support and resources because of lack of information on the socioeconomic importance, morphometric characteristic and meat quality of indigenous chickens. A cross sectional survey was conducted to highlight the major constraints to production. A structured questionnaire was administered to 126 households selected from communities of Mnambiti-Ladysmith and Impendle local municipalities of KwaZulu-Natal Province of South Africa. The mean flock size per household was 20 and 17 for Mnambiti-Ladysmith and Impendle, respectively. The cock to hen ratio was 1:2:5. The chickens were mostly kept for meat and income ranked 1 and 2 respectively. Generally, adult females made the majority of decisions on chicken management and marketing (61%), with youths playing a minor role. Scavenging was the major feeding system, seasonally supplemented with cereal grain. The majority of the farmers (87%) provided birds with drinking water. Mortality of chickens was prevalent (46%) in both seasons.

In experiment 2, the objective of the study was to compare morphometric characteristics of Black Australorp, Potchefstroom Koekoek, Venda and Ovambo chickens. A flock of 200 indigenous chickens, 50 each of Black Australorp, Potchefstroom Koekoek, Venda and Ovambo breeds were reared under semi-intensive system for 22 weeks. The chickens were slaughtered at 22 weeks of age by manual neck cut, bled for 2 minutes and de-feathered. Body weights, organ weights and linear body measure were estimated using flexible tape prior to slaughter. The body weight for the Black Australorp were higher (P<0.05) than the other breeds. There was no significant difference between the lung, heart kidney and spleen weights among breeds. Linear regression revealed that measurements of linear body parts can be used to predict weight of the birds.

The objective of Experiment 3 was to compare consumer acceptability of meat from chickens that are indigenous to South Africa compared to Black Australorp and the broiler. A flock of 200 unsexed freely ranging indigenous chickens of Potchefstroom Koekoek, Venda, Black Australorp and Ovambo breeds were reared under an improved semi-intensive system for 22 weeks. The acceptability of cooked meat samples from each breed was rated on a 9 point Hedonic scale by 69 consumer pannellists drawn from the University of KwaZulu-Natal, Cedara College of Agriculture and the Depart of Agriculture. Age of consumer had no effect on all the sensory attributes of the meat evaluated (P> 0.05). Chicken breed had a significant effect on taste and overall acceptability (P< 0.05) with the Venda, Broiler and Black Australorp, but it had no significant difference on colour, texture and aroma acceptability. Gender of the consumer had a significant effect (p<0.01) on taste, colour and texture acceptability of the meat, but no significant effect on aroma and overall acceptability. Female respondents gave lower scores for taste than did the males (P< 0.01). There was no interaction between gender of consumer and chicken breed on meat texture. Crossbreeding the indigenous chickens with improved breeds such as the Black Australorp is one avenue through which sensory characteristics of the indigenous chickens may be improved

Key words: Black Australorp, Consumer acceptability, Food Security, Indigenous chickens, Morphometric traits, Ovambo chicken, Potchefstroom Koekoek chickens, Venda chickens.

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Dedication

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Chapter 1: Introduction

Indigenous chickens (*Gallus domesticus*) refer to birds that have been kept under extensive production system for centuries. The majority of them have been shown to have originated from South East Asia. They scavenge for feed and have no identified description and generally unimproved (Pedersen, 2002). Indigenous chickens are the most common types of poultry raised under communal production systems in Southern Africa. Indigenous chickens are multi-coloured, long legged and smooth feathered with a few fizzled feathered, naked necked and dwarf birds (Mogesse 2007; Mtileni *et al*., 2009). These chickens play various socio-economic roles in traditional religious and other customs, such as gift payments and serve as an important source of animal protein (McAinsh *et al*., 2004). Their role as a potential tool for wealth creation and contribution to the nutrition of low income farming communities in South Africa is undoubted (Swatson *et al*., 2002; Mtileni *et al*., 2009). They are owned or kept by almost every household and are rarely associated with religious taboos, have short generation intervals and higher rates of prolificacy. Indigenous chickens also require low costs of maintenance and are greatly adaptive feature to the harsh pedo-climatic and socioeconomic conditions found in rural areas (Pedersen, 2002).

The last decade has witnessed an increase in consumer preference for coloured feather and slow-growing meat-type indigenous chickens presumably due to their perceived superior meat flavour, meat texture and health benefits compared to commercial strains raised intensively. It is necessary that communal farmers strive to increase production of indigenous chickens to exploit the economic gains presented by the growing demand. Although numerous studies have compared the productive performance and quality of eggs from indigenous chickens (Van Marle-

Köster and Webb, 2000; Van Marle-Köster and Casey, 2001; Grobellar *et al.,* 2010), very few studies, if any, have compared the carcass characteristics, meat quality, and sensory properties of the meat from specific indigenous chicken genotypes. In addition, the majority of the reports fail to recognise the inherent differences among indigenous genotypes and broadly refer to all of them as a homogenous population (Akanno, 2007).

Although unselective crossbreeding is prevailing, the characteristics and adaptability of individual breeds need to be documented. Differences in morphometric characteristics and sensory properties of their products need to be understood. Information generated from this study could be useful in identifying the indigenous breeds that could be used for different production and consumer preferences, resulting in up scaling of the production of meat from extensive production systems based on specific native genotypes. Indigenous breeds require fewer nutrients than the exotic breeds and they have greater instincts to survive predation and diseases (Badhaso, 2012). Therefore, promotion of these genotypes will boost protein consumption by the poor. The resource poor farmers can benefit hugely from this growing market. Support and promotion of increased production and productivity of indigenous chickens would be of economic benefit to the resource poor farmers and would also contribute to improving their livelihoods.

1.1 Justification

Information about characteristics of production systems, populations and distribution, socioeconomic importance and constraints to indigenous chicken production in the high rainfall areas of South Africa is still limited. Such information is useful in identifying possible areas of improvement and the strategic entry points for research.

Morphometric measurements are useful in contrasting size and shape of animals (McCracken et al., 2000). It is important that communal farmers monitor the growth performance of their chickens to know when they have attained the desired market weight. In places where scales are not available as is the case in most rural African communities (Nesamvuni *et al*., 2000), linear body measurements such as shank length, drum stick length and wing length can be used in a predictive equation to predict body weight in chickens (Akanno *et al*., 2007). Morphometric measurements are useful to farmers in rural areas since they cannot afford to buy weighing scales so they can easily estimate body weight and weights of organs like the liver, gizzard, heart, lungs etc. The Department of Agriculture DoA, researchers and non-governmental organisations (NGO) can also use the information when developing extension strategies for smallholder farmers. There is very little information, if any, on characterization of morphometric characteristics and consumer acceptability of meat from Black Australorp Potchefstroom Koekoek, Venda and Ovambo chickens. These chickens are very common in the communal areas so it is of great importance to assist communal farmers.

1.2 Objectives

The broad objective of the study was to characterize indigenous chickens in South Africa. The specific objectives of the study were to:

1. Characterize the village chicken production systems in two rural districts in the highveld of KwaZulu-Natal Province in South Africa.
2. Compare morphometric characteristics of Black Australorp, Potchefstroom Koekoek, Venda and Ovambo chickens.
3. Assess the consumer acceptability of meat from indigenous breeds of chicken.

1.3. Hypothesis

The hypothesis tested:

1. There was no Characterize the village chicken production systems in two rural districts in the highveld of KwaZulu-Natal Province in South Africa
2. There were differences that exist in morphometric characteristics of the Black Australorp, Potchefstroom Koekoek, Venda and Ovambo
3. There are differences in sensory attributes among the Black Australorp, Broiler, Venda, Ovambo and the Potchefstroom Koekoek.

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Chapter 2: Review of Literature

2.1 Introduction

Poultry production plays a vital role in the improvement of the income and food security of the communal poultry producers (Sonaiya, 2003). Indigenous chickens contribute greatly to human supply of eggs and meat in tropical and subtropical areas (Al-Atiyat, 2009). These chickens are a source of protein to the ever-increasing population in developing countries (Dyubele *et al.*, 2010). They are raised without regular feeding from the owners. They ramble around the houses to get their feed. They are not sold at a precise age but when their owners need some extra money. For villagers, such birds represent a type of savings to face special situations (e.g. sickness, payment of school fees, and to slaughter at important social gatherings). Rural farmers prefer indigenous chickens because they are not capital intensive (Muchadeyi, 2007). Farmers are usually smallholders, landless individuals and industrial labourers who rear these birds because of their adaptability and compatibility to the environment and activities of the owners. These chickens are hardy, adapt well to rural environments, survive on little inputs and adjust to fluctuations in feed availability (Kingori *et al*., 2003). This chapter gives emphasis on the role of indigenous chickens to sustainable livelihood, chicken breeds used in communal production systems, morphometric traits and sensory evaluation.

2.2 Role of indigenous chickens to sustainable livelihoods

Village poultry makes a substantial contribution to household food security throughout the developing world. Indigenous chickens make a substantial contribution to household food security throughout the developing world (Besbes, 2009). Indigenous chickens are kept using household labour and, wherever possible, locally available feed resources. These chickens range freely in the household compound and scavenge for their own feed, getting supplementary amounts from the farmer. These are defined rural as a flock of less than 100 birds, of unimproved or cross breeds, raised in either extensive or semi-intensive and exhibit remarkable adaptation to local environments and diseases (Sonaiya, 2003). The multitude functions of indigenous chickens include the provision of high quality protein meat and eggs, cash through sales, manure and socio-cultural roles (Nhleko *et al.*, 2003) reported that indigenous chickens are among the most adaptable domestic animals that can survive cold and heat, wet and drought, sheltered in cages, unsheltered outside or roosting in trees. Some farmers keep these chickens for household production (meat and eggs) only. Other farmers keep them for household production (meat and eggs) and to supplement their income.

There are various advantages which make indigenous chickens attractive in the context of poverty alleviation and quality protein supply than cattle, sheep, goats and pigs (Mapiye, 2008), village chickens in one form or another are kept in most areas and there are hardly any religious or social taboos associated with them (Pedersen, 2002). They have high reproduction rate per unit time, they are efficient in transforming feed protein and energy into human food, they use very low capital, labour and space, which allows chicken production to be practiced even by landless individuals (Muchadeyi *et al*., 2004). Village chickens are easily liquidated, and eggs and meat represent consumable units that do not require specialized storage and preservation facilities (Mapiye and Sibanda, 2005). Despite their low egg production (between 35 and 45 eggs/hen/year), indigenous chickens are also an important element in diversifying agricultural production and increasing household food security. Chickens were primarily kept for household meat (90 %), while egg consumption (64%) ranked as a second priority (Mtileni *et al*., 2009) and to a less extent for manure, cultural ceremonies and income generation. Indigenous chickens are a significant component of the rural household livelihood by providing a source of income and nutrition, and as gifts to strengthen social relationships particularly in developing countries, such as South Africa.

Indigenous chickens help diversify incomes, provides high-quality food and fertilizer, and act as form of household savings and insurance. As keeping scavenging poultry is an activity that is generally carried out by women, it also contributes to women's empowerment. Furthermore, experiences in Bangladesh have shown that village poultry can be used as a tool for poverty alleviation (Jensen and Dolberg, 2002). Therefore, all over the developing world, these low-input, low-output poultry-husbandry systems are an integral component of the livelihoods of most of rural and peri-urban, and some urban, households, and are likely to continue to meet this role for the foreseeable future. The approximate estimates produced by Pym et al. (2006) suggest that the contribution of indigenous genotypes to egg consumption is probably quite low in most countries, but that the contribution to meat production and consumption is likely to be quite substantial. Some farmers use these breeds for natural tick and fly control by placing a movable chicken house at their kraals or by having a chicken house close to their dairy. Development of village chicken production can be a sustainable way of helping to meet the welfare needs of rural populations and raise their living standard.

2.3 Chicken breeds used in communal production systems of South Africa

Communal chicken production refers to birds kept under extensive system, scavenging in the free range, have no identified description, multi-purpose and unimproved. The most common South African breeds kept in communal areas include Naked Neck, Venda, Ovambo and

Potchefstroom Koekoek. There are other European breeds that are kept under free range in communal production systems, such as the New Hampshire, Rhode Island Red and the Black Australorp. These all can survive in this environment, although generally more susceptible to diseases, not as hardy and more prone to predation.

2.3. Imported breeds

2.3.1.1 Black Australorp

In communal production systems of South Africa the Black Australorp is the most commonly used imported breed of chickens. The Australorp chicken was developed from the English Orpington. In 1929, the Australorp chicken was admitted to the Standard of Perfection. Australorp chickens are black in colour. Males have an average weight 3.85 kg and females 2.94 kg (Fourie and Grobbelaar, 2003). The Black Australorp is an Australian chicken breed. It is a large, soft-feathered bird with glossy black feathers and a lustrous green sheen. The Black Australorp is hardy, docile and a good egg-layer as well as meat bird. The Australian chicken's single comb is moderately large and upright, with five distinct points.

2.3.2 Indigenous breeds

The Potchefstroom Koekoek, Ovambo and Venda are the most common indigenous chickens in South Africa

2.3.2.1 Potchefstroom Koekoek

The Potchefstroom Koekoek was bred at the Potchefstroom Agricultural College during the 1950s (Fourie and Grobbelaar, 2003). This breed is a composite of the White Leghorn, Black Australorp and Bared Plymouth Rock. It can, therefore, be considered as a locally developed breed. The name Koekoek refers to the barred colour pattern of the birds. The Potchefstroom

Koekoek was developed for the hens to lay brown shelled egg and the carcass should be attractive with a deep yellow skin colour. The Potchefstroom Koekoek cocks and culled hens are used for meat production. Today the meat of this breed is popular among local communities and is preferred to that of the commercial broiler hybrids (Grobbelaar, 2008). The Koekoek's colour pattern is a sex-linked gene that is useful for colour sexing in cross-breeding for egg producing types of hens used in medium input production systems. The breed is popular among rural farmers in South Africa and neighbouring countries for egg and meat production as well as their ability to hatch their own offspring (Grobbelaar, 2008).

2.3.2.2 Venda

Venda chickens are multicoloured with white, black and red as the predominant colours (Fourie and Grobbelaar, 2003). Rose-coloured combs and five-toed feet are not uncommon. It is fairly large and lays tinted large eggs. The hens are broody and very good mothers.

2.3.2.3 Ovambo

The Ovambo chickens originated in the northern part of Namibia and Ovamboland. It is dark-colored. It is smaller in size. It is very aggressive and agile (Fourie and Grobbelaar, 2003). It has been known to catch and eat mice and young rats. This chicken can fly and roosts in the top of trees to avoid predators. They reach sexual maturity at 20 weeks.

2.4 Morphometric traits of indigenous chickens

Morphometric traits are used as an indicator of bone status in nutritional and genetic research of poultry. Information on the structure of body morphometric and its various parameters in chickens and other birds are essential for an understanding of growth and development (Bell *et al.,* 2007). Moreover, body weight and body morphometric in chickens have been used to differentiate native from exotic (Mulyono *et al.* 2009) and commercial (Vitorović *et al.* 2009) breeds, and to establish phenotypic correlations among various genetic groups (Yakubu *et al.* 2009).Morphometric measurements have been found useful in contrasting size and shape of animals (McCracken *et al*., 2000; Latshaw and Bishop, 2001; Afolayanetal., 2006; Ajayi *et al*., 2008). Indigenous chickens are alert and have long shanks with which they use to run away from predators. If necessary, they even fight with predators to safeguard their chicks (Besbes, 2009). These breeds are well-adapted to diverse temperatures and to scavenging for food. They eat a variety of materials including grass seeds, household scraps, insects and small rodents.

Indigenous chickens generally have small body sizes; for various African and Asian chicken breeds, mature body weight varies between 1.3 and 1.9 kg for males and between 1.0 and 1.4 kg for females (Musharaf, 1990; Shanawany and Banerjee, 1991). Adaptability of indigenous chickens in the tropical environment has been through reduction in body sizes as a means of reducing maintenance feed requirement and increasing feed efficiency (Rashid *et al.*, 2005). Smaller body sizes reduces maintenance feed requirements and increase feed efficiency. This is necessary for survival in the free range system because of scarce feed resources and the uncertainty surrounding feed supply. The small size is probably responsible for the continued existence of the ecotypes in their respective habitats (Olawunmi, 2008).

The shank and thigh lengths are the measurement of the height of the birds. Since the exotic males that are raised exclusively for meat are rather characteristically taller than their laying counterparts, therefore these traits can be used to determine if a chicken is a meat producer or a layer. The body length and head length of the bird confers the superiority for egg laying

2.5 Measures of meat quality

Meat quality is a generic term used to describe properties and perceptions of meat. It includes attributes such as carcass composition and conformation, the eating quality of the meat (Maltin *et al.*, 2003). These factors combine to give an overall assessment of meat quality by the consumer. Consumer evaluation of eating quality is the major determinant of meat quality, with tenderness, juiciness and flavour of meat being the most important elements (Maltin *et.al*, 2003).

2.5.1 Sensory evaluation

Sensory evaluation is perceived by the senses of sight, smell, taste, touch and hearing (Ruan and Xianyi, 2004). Sensory analysis is one of the oldest means of quality control and is an essential part of the assessment of food quality (Neumann and Arnold, 1990; Pokorny, 1993). Sensory evaluation can be done by using trained taste panels or consumers. Trained sensory panels function as laboratory instruments and hence, their judgment usually matches results of instrumental evaluations of meat quality (Simela *et al.,* 2008). Although laboratory methods can provide precise and reliable information concerning sensory attributes, consumers provide reliable and appropriate information about the acceptability of the meat (Simela *et al.*, 2008). Consumers tend to evaluate cooked meat quality on the basis of tenderness, juiciness and flavour. The advantage of using consumers over panelists is that they are the end users of the meat and they give a real life assessment of meat quality. Unfortunately, their sentiments and perceptions are largely ignored in most studies.

Many authors note that the sensory analysis, allowing manufacturers to identify, understand and respond to consumer preferences more effectively (Liu *et al.,* 2004; Fanatic *et al.*, 2007; Saha *et al.*, 2009) and in addition the identification of sensory characteristics and consumer preferences, helping manufacturers to increase competition in the market for other producers (Tabilo *et al.*, 1999; Tan *et al.*, 2001; Lawlor *et al.*, 2003; Ponte *et al.*, 2004; Young *et al.*, 2004). Meat tenderness and flavour appear to be the most important sensory characteristics that determine meat quality (Sañudo *et al.*, 1996; Tshabalala *et al.*, 2003). The more tender the meat, the more rapidly juices are released by chewing and the fewer residues remain in the mouth after chewing (Muchenje *et al.*, 2008).

Lately, there has been a growing countervailing trend where consumers show renewed interest in differentiated food products. This differentiation relates to animal welfare aspects and environmental, food safety and human health considerations, just as locally produced foods and sensory properties of the food are important. Many authors have showed that sensory analysis allows producers to identify, understand, and respond to consumer preferences more efficiently (Hashim *et al.*, 1995; Owens and Sams, 1998; Liu *et al.*, 2004; Fanatico *et al.*, 2007; Saha *et al.*, 2009). Furthermore, the identification of sensory characteristics and consumer preference helps industry producers to segment their market and to increase their competition strengths (Tan *et al.*, 2001; Lawlor *et al.*, 2003; Ponte *et al.*, 2004; Young *et al.*, 2004).

2.6 Summary

Indigenous chickens are hardy and can withstand harsh climatic conditions. There is a higher demand for organic meat from these chickens as it is believed there are tastier. It is also said that indigenous chicken meat has lower fat content. It is, therefore, important to develop research and development programs to improve the quality of indigenous chicken production and test consumer acceptability of meat from these chickens.

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Chapter 3: Characterization of Indigenous Chicken Production Systems in the Highveld Areas of South Africa

Abstract

Indigenous chicken production in most rural areas has failed to lay legitimate claims to institutional support and resources because of lack of measurable indicators and information about production systems, population size and distribution, productivity and the socioeconomic importance of indigenous chickens. A cross-sectional survey was conducted to generate information on the characteristics of indigenous production systems, as well as highlighting the major constraints to production. A total of 126 households drawn from indigent communities of Mnambiti-Ladysmith and Impendle local municipalities of KwaZulu-Natal Province of South Africa were selected to respond to a standard questionnaire using the snowball technique.The free range system was practiced by all the households. The mean flock size per household was 20 and 17 for Mnambiti-Ladysmith and Impendle, respectively. The cock to hen ratio was not significantly different between Ladysmith and Impendle (1:2.5). The chickens were mostly kept for meat and income ranked 1 and 2 respectively. Generally, adult females made the majority of decisions on chicken management (62%) and marketing, with youths playing a minor role. Chickens were mainly acquired through purchasefrom neighbours (57.9%) and gifts (23.0 %). Scavenging was the major feeding system, seasonally supplemented with cereal grain. The majority of the farmers (87%) provided birds with drinking water. Mortality of chickens was prevalent (46%) throughout the year and was mainly attributed to unspecified diseases. Almost all the farmers did nothing when their birds fell sick. It can be concluded that indigenous chickens are a major resource in the communal areas and poor nutrition and health were the major constraints.

Key words: Indigenous chickens, Management system, Nutrition, Health and Food security

3.1 Introduction

There is a general agreement among scientists, economists, and policy makers that the greater part of extreme poverty in the global South is a rural phenomenon (Aklilu *et al*., 2007). Although the absolute prevalence of food insecurity in South Africa is not known, available data suggests that between 35 and 75 % of South African households experience food insecurity (Hendriks, 2005; Hendriks *et al.,* 2006). An estimated 60 % of the national average of stunted children is found in rural areas while two thirds of South Africans are considered poor (National Department of Agriculture, 2002). The number of people living in poverty in South Africa has increased since the end of apartheid in 1994, with the prevalence of malnutrition remaining substantially higher than in developed countries (Aliber, 2003). Meth and Dias (2004) have warned that these numbers might increase over time unless sustainable interventions to alleviate food insecurity are undertaken to increase both dietary intake and income generation.

The indigenous chicken population in South Africa is not known due to lack of detailed livestock census. However, it is estimated that more than 140 million indigenous chickens exist in South Africa (FAOSTAT, 2007). Development and promotion of indigenous chicken production can be a sustainable way to provide the nutritional, income, employment and gender needs of the rural population (Kusina and Kusina, 1999). There are several reasons why chickens are more important for targeting poverty in rural areas than cattle, sheep, goats or pigs, the major ones being their ubiquity and omni-presence among rural households, short generation intervals, higher rates of prolificacy, low cost of maintenance and a great adaptive feature to the pedo-climatic and socioeconomic conditions found in rural areas (Pedersen, 2002).The chickens are usually raised under a traditional low input – scavenging type of production system with little investment on disease control and prevention, supplemental feed or housing which, results in low output from high losses and low productivity (Swatson et al., 2003; Mtileni *et al.,* 2009; Mwale *et al.,* 2011). The traditional system makes use of free feed resources in the surrounding environment including kitchen leftovers and more importantly, the use of local breeds that are adapted to their environment (Magwisha *et al.,* 1997; Pedersen *et al.,* 2002). However, poor reproductive performance, poor growth rates, diseases, mortality and predation are some of the major constraints in the traditional system (Salum *et al.,* 2002; Conroy *et al.,* 2005). Despite the poor production environment, indigenous chickens have been able to adapt and satisfy the multiple economic, social and cultural needs of rural households.

Indigenous chickens provide a scarce but cheap source of high quality protein in the form of meat and eggs, and can be sold or bartered to meet essential family needs. The chickens also fulfill a number of other functions for which it is difficult to assign any monetary value. For example, indigenous chickens are active in pest control, provide manure, and are essential for many traditional ceremonies. Considering the vital role that indigenous chicken production plays in household food and financial security, it is imperative that their production environment be clearly understood. Although there is a growing body of published literature on characterization of indigenous chicken production systems (Swatson *et al.,* 2002; Nhleko *et al*., 2003; Mtileni *et al.,* 2009; Mwale *et al.,* 2009; Rwanedzi, 2010), information about characteristics of production systems, populations and distribution, socioeconomic importance and constraints to indigenous chicken production in the high rainfall areas of South Africa is still limited. Such information is useful in identifying possible areas of improvement and the strategic entry points. The objective of the current study was to characterize the village chicken production systems in two rural districts in the highveld of KwaZulu-Natal Province, South Africa.

3.2 Materials and methods

3.2.1 Study sites

The study area covered three adjacent villages in Mnambiti-Ladysmith local municipality namely Manzabilayo, Mcitsheni and Pieters, and one village, Nzinga, in Impendle local municipality. Mnambiti-Ladysmith and Impendle local municipalities are found in Uthukela and UMgungundlovu District Municipalities of KwaZulu-Natal Province in South Africa, respectively.

Mnambiti is located within the coordinates 28°33′S 29°47′E. Altitude is approximately 1052m above sea level (Garmin GPSMAP 76CS, Garmin Ltd, www.garmin.com). Mean annual rainfall is in the range 600 to 900 mm with about 80 % falling between November and March. Total annual precipitation is usually reliable to support intensive mixed crop-livestock production. Mean daily maximum temperatures range from 20°C in June to 28.1°C in January. The region is the coldest during July when the temperature drops to 3.1°C on average during the night. The district has two distinct seasons: a wet warm season (September to April) and a short dry season (May to August. In the current study, seasons were defined as a hot wet season (September to April) and a short cool dry season (May to August), to take account of ambient temperature changes. The district has a population density of 76 people/km^2. Most of the households belong to the Zulu tribe and are predominantly cattle farmers.

Nzinga lies along longitude 29°76′E and latitude 29°63′S at an altitude of 4442 m above the sea level. Mean annual rainfall is in the range 800 to 1200mm with about 80 % falling between December and March. Total annual precipitation is usually reliable to support intensive mixed crop-livestock production. Mean daily maximum temperatures range from 15°C in June to 22°C in February. The region is the coldest during June when the temperature drops to -3.1°C on average at night. Nzinga is extremely diverse in its topography, climate and soils, and has a rich and complex natural environment. The municipality covers an area of 948.8 km^2. The population density in these villages is approximately 41.5 people/km^2.

3.2.2 Farmer selection procedures

In both study local municipalities, farmers were selected following recommendations of local veterinary and agricultural extension agents. Because the number of farmers involved in indigenous chicken production in the study areas was not known, due to unavailability of reliable statistics, random sampling of farmers proved difficult and it became necessary to resort to linear snowball sampling (Heckathorn, 2002). Interviewed households assisted in the recruitment of more interviewees from among their acquaintances. Responses were obtained from 61 and 65 households in Mnambiti and Impendle, respectively.

3.2.3 Data collection

Two methods were used in the collection of data: a rapid appraisal that entailed focus group discussions, followed by a sample survey. Focus group discussions were held with members of the district livestock development committees. In each district, 10 members were interviewed. Semi-structured interview that covered aspects such as ownership of chickens, feeding and watering of chickens, types of feed, health of chickens, and labour use among household members. Responses were used in the development of the questionnaire to be used in the sample survey. The resulting questionnaire was pre-tested in the same study sites.

Permission to carry out the study was sought from the village chief or headman and farmers were forewarned of the study by the agricultural extension agent. Structured questionnaires were then used to gather data on farmers' socio-demographic profiles, flock size and structure, the relative importance of free range, indigenous chickens to the welfare of rural households, husbandry practices and constraints to production. Direct observations on locally available feed resources and water availability were made during transect walks.

Five enumerators were involved in the administration of the questionnaire. All were given a one-day training session at which they were introduced to the objectives of the study and taken through the questionnaire. All survey work was conducted between January and March 2011. The questionnaire was administered in the local Zulu language.

3.3 Statistical analysis

Qualitative data were subjected to frequency distribution analysis using the PROC FREQ procedure of SAS 2006. Cross-tabulations were generated to determine the association between factors. Chi-square test was used to determine the strength of the association. PROC GLM and correlation procedures of SAS 2006 were used to analyse quantitative data. A non-parametric Kruskal-Wallis test generated from the NPAR1WAY procedure of SAS 2006 was used to analyze the ranking of the different reasons of keeping chickens between the two districts by comparing the mean ranks from the two districts.

3.4 Results

3.4.1 Socioeconomic status of the respondents

The characteristics of respondents are shown in Table 3.1. Of the 126 indigenous chicken farmers interviewed, 62 and 38% were female and male, respectively. The average age of the respondents was 45 years. Overall, very few (21.4%) of the respondents had received some form of agricultural training. The mean household size was 6.6 and ranged between 1 and 19 persons. About 90 % of heads of households were resident on the farm, without formal employment and subsisting on various government grants as the main sources of income. The average farm size per household was estimated at 2.1 ha (range 1.2- 3ha) and 0.6 ha (range 0.5 – 1.2 ha) in Mnambiti and Impendle, respectively.

Table 3.1: Demographic and socioeconomic status of indigenous chicken owners in Mnambiti and Impendle

Variable	Mnambiti	Impendle	Overall
Sample size (n)	61	65	126
Sex of respondents (%)			
Male	26.23	49.23	38.1
Female	73.77	50.77	61.9
Average age of respondents (years)	35	55	45.1
Agricultural training	13.1	29.2	21.4
Household heads residing on farm (%)	80.3	97	88.9
Mean household size (mean±sd)	6.27±2.92	6.86±3.22	6.6
Total land holding (ha)	2.1	0.6	1.3

3.4.2 Livestock production

Livestock species kept by farmers in the two districts were chickens, goats, cattle, pigs and sheep (Table 3.2). The composition of livestock owned by farmers varied between households, but not between districts (P > 0.05). Indigenous chickens were the most abundant livestock kept by the respondents, accounting for approximately 65% of the total livestock kept by the farmers. There was no significant difference (P > 0.05) in the chicken flock size per household (Table 3.3). The average flock size per household was 20.1 and 17.6 birds/household in Mnambiti and Impendle, respectively (Table 3.3). Nearly 60 % of the farmers in Mnambiti had an average holding of 6.52 goats per household, (Table 3.3). In Impendle, the average holding was lower, with 3.72 goats per household (Table 3.3). The mean cattle herd size per household in Mnambiti was 4.86 while farmers in Impendle had an average of 3.95 beasts per household (Table 3.3). As shown in Table 3.3 only nine (15%) and 3 (4.6%) farmers owned pigs in Mnambiti and Impendle, respectively. Mean pig herd size was 0.63 ±0.061 pigs per household (Table 3.3). Sheep were the least popular in both study areas with only 6 farmers owning an average of 7 animals per household (Table 3.3).

Table 3.2: Populations and distribution of livestock in Mnambiti and Impendle

Species	Mnambiti (N=61)				Impendle (N=65)			
	No. of livestock	% of total livestock	No. of farmers	% of farmers	No. of livestock	% of total livestock	No. of farmers	% of farmers
Chicken	1237	62.12	61	100	1142	68.4	65	100
Goats	398	19.98	35	57.38	242	14.5	31	47.69
Cattle	297	14.91	31	50.82	257	15.4	31	47.69
Sheep	20	0.010	2	3.28	25	0.015	4	6.15
Pigs	39	0.019	9	14.75	4	0.0023	3	4.62
Total livestock	1991	100			1670	100		

Table 3.3: Means of livestock species per household in Mnambiti and Impendle districts

Species	Mnambiti (N=61)		Impendle (N=65)	
	Mean ± s.e.	Range	Mean ± s.e.	Range
Chicken	20.27±11.84	2-53	17.56±9.06	4-60
Goats	6.52±8.89	0-35	3.72±5.24	0-22
Cattle	4.86±7.04	0-28	3.95±6.42	0-35
Sheep	0.32±2.31	0-18	0.38±1.91	0-14
Pigs	0.63±2.02	0-11	0.061±0.29	0-2

3.4.3 Chicken flock structure

The mean flock composition per household in the two rural districts is shown in Table 3.4. Overall, chicks formed the largest proportion of the flock, followed by hens, pullets, cocks and cockerels were the least. The cock to hen ratio was found to be 1:2.17 and 2.84 for Mnambiti and Impendle, respectively, as shown in Table 3.4.

3.4.4 Main functions of chickens

Farmers indicated the multiple functions of indigenous chickens but the majority ranked meat consumption as the most important function (Table 3.5). Meat consumption was followed by cash income, manure, investment and cultural roles. The functions of chickens did not differ between districts (χ^2 = 7.143; P > 0.05). Focus group discussions revealed that cash from chickens was primarily spent on food purchases and payment of school fees, followed by medical bill/expenses. Other expenditures included restocking, transport, labour, death/funeral, ceremonies and helping others. Indigenous chickens thereby contributed directly and indirectly to food security, education and human social welfare. The importance of chickens particularly for the livelihoods of resource-poor farmers cannot be overemphasized.

Table 3.4: Average flock composition by age-grouping Mnambiti and Impendle districts

Age group	Mnambiti		Impendle	
	No. of birds	% of total flock	No. of birds	% of total flock
Chicks	527	39.12	307	26.17
Pullets	185	13.73	185	15.77
Cockerels	101	7.49	113	9.63
Hens	366	27.17	420	35.80
Cocks	168	12.47	148	12.61
Total livestock	1347		1173	
Sex ratio (cock:hen)	1:2.17			1:2.84

Table 3.5: Functions of indigenous chickens as ranked by smallholder farmers in Mnambiti and Impendle districts

Reason	Rank(mean score)		
	Mnambiti	Impendle	Total
Meat and eggs	1 (1.49)	1 (1.41)	1 (1.45)
Cash	2 (2.29)	2 (2.66)	2 (2.48)
Manure	3 (3.70)	3 (3.40)	3 (3.54)
Investment	4 (4.24)	4 (4.21)	4 (4.23)
Socio-cultural	5 (4.90)	5 (4.98)	5 (4.94)
Kruskal-Wallis	***	***	***

The lower the rank of the score, the greater is its importance.

*** $P < 0.05$

3.4.5 Chicken ownership patterns within households

Overall, most of chickens were owned by women (64.2%), followed by men (26.3%) and the remainder by male children (0.07%) and female children (0.02%). There was a significant association between district and chicken ownership (χ^2 = 7.143; P < 0.05). There was a disproportionately higher percentage of women who owned chickens in Mnambiti (73.77%) compared to Impendle where ownership was balanced between the gender groups. Regardless of district, children had a marginal share (< 1%) in chicken ownership (χ = 7.060; P > 0.01). Although the association between sex of household head on flock size was not statistically significant (χ^2=0.45; P > 0.05), there were more female-headed households keeping smaller (< 18 birds) chicken flocks (60.3 %) while male-headed households kept larger (> 18 birds) flocks (45.8%). Households with a male component were generally better off in terms of chicken ownership than female-headed households, thus the latter were more vulnerable. Heads of households within the 40 to 60 years age groups kept smaller flocks while the age group 30 to 40 years kept larger flocks, although the association between age of household head on flock size was not statistically significant (χ^2=9.383; P > 0.05). Although the effect of agricultural education on the flock size categories was not significant (χ^2=0.36; P > 0.05), the majority of these illiterate farmers dominated the chicken enterprise with 76.7% keeping small flocks and 81.30% keeping large flocks.

3.4.6 Decision making in chicken management and marketing

The contribution of family members to the decision-making process with regard to chicken production and marketing is shown in Figure 3.1. The association between district and decision making was not significant (χ^2= 3.61; P > 0.05). Generally, the adult heads of households made the majority of decisions on chicken management and marketing, with youths playing a minor role. Adult females were involved in decisions on all aspects of chicken husbandry and marketing such as purchases, sales, breeding, nutrition and health while fathers were distinctly active in passing decisions regarding the sale of chickens.

3.4.7 Sources of chickens

The various sources of chicken stocks are shown in Figure 3.2. Generally, farmers acquired their chickens through purchases from their neighbours (57.9% of the respondents), gifts (23%), inheritance (16.7%) and other (4%). Most purchases were based on the body size, sex and health of the bird depending on the farmer's preference. There was a significant association between districts and sources of their chicken stock, with more farmers (71%) in Impendle acquiring their chickens through purchases and fewer through inheritance (14%) and gifts (15%) than in Mnambiti (χ^2 = 11.05; $P < 0.05$). Only 44% of the farmers in Mnambiti acquired their chickens through purchases with the remainder acquiring them through gifts (31%) and inheritance (19%).

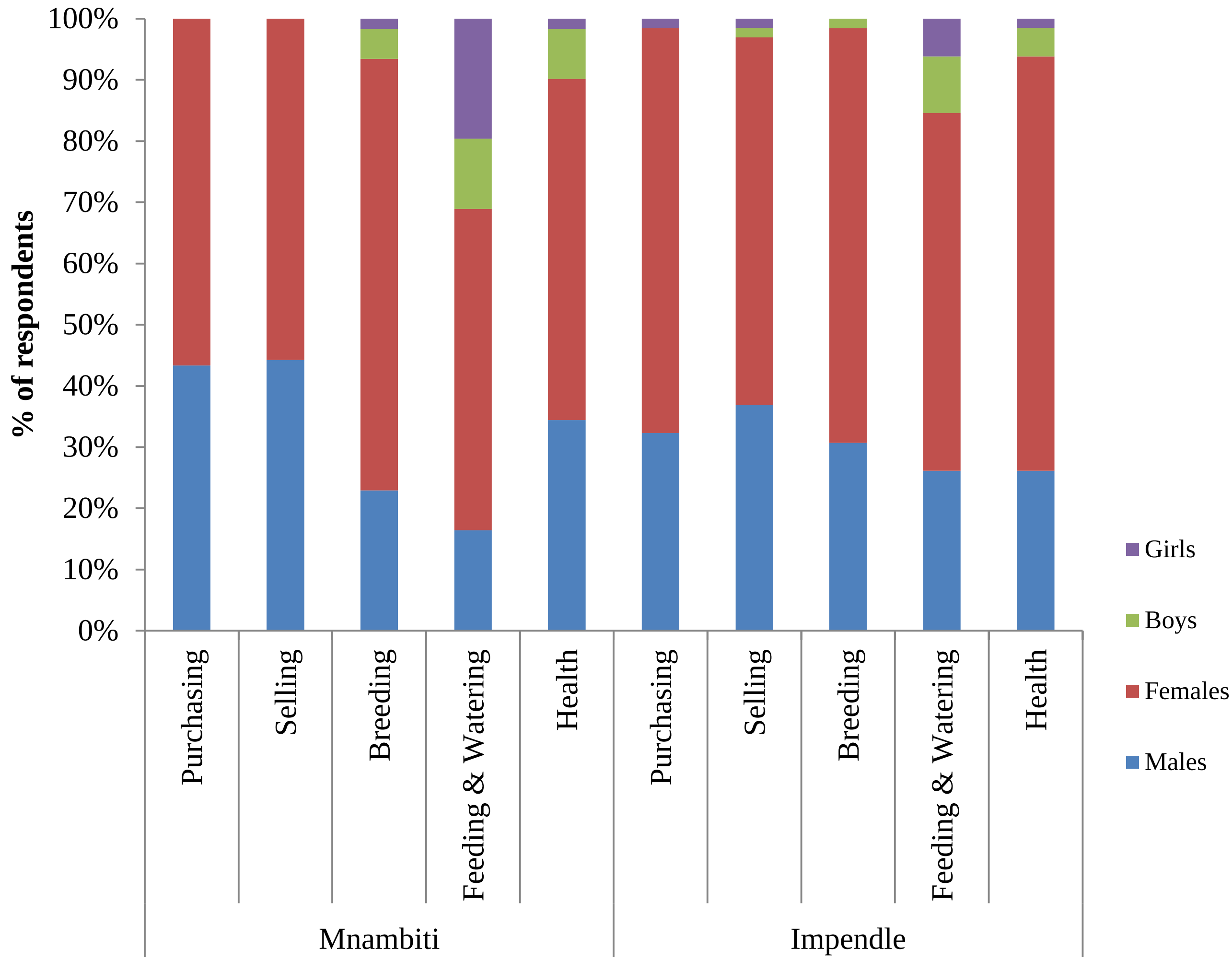

Figure 3.1: Decision making in chicken management and marketing by communal farmers in Mnambiti and Impendle

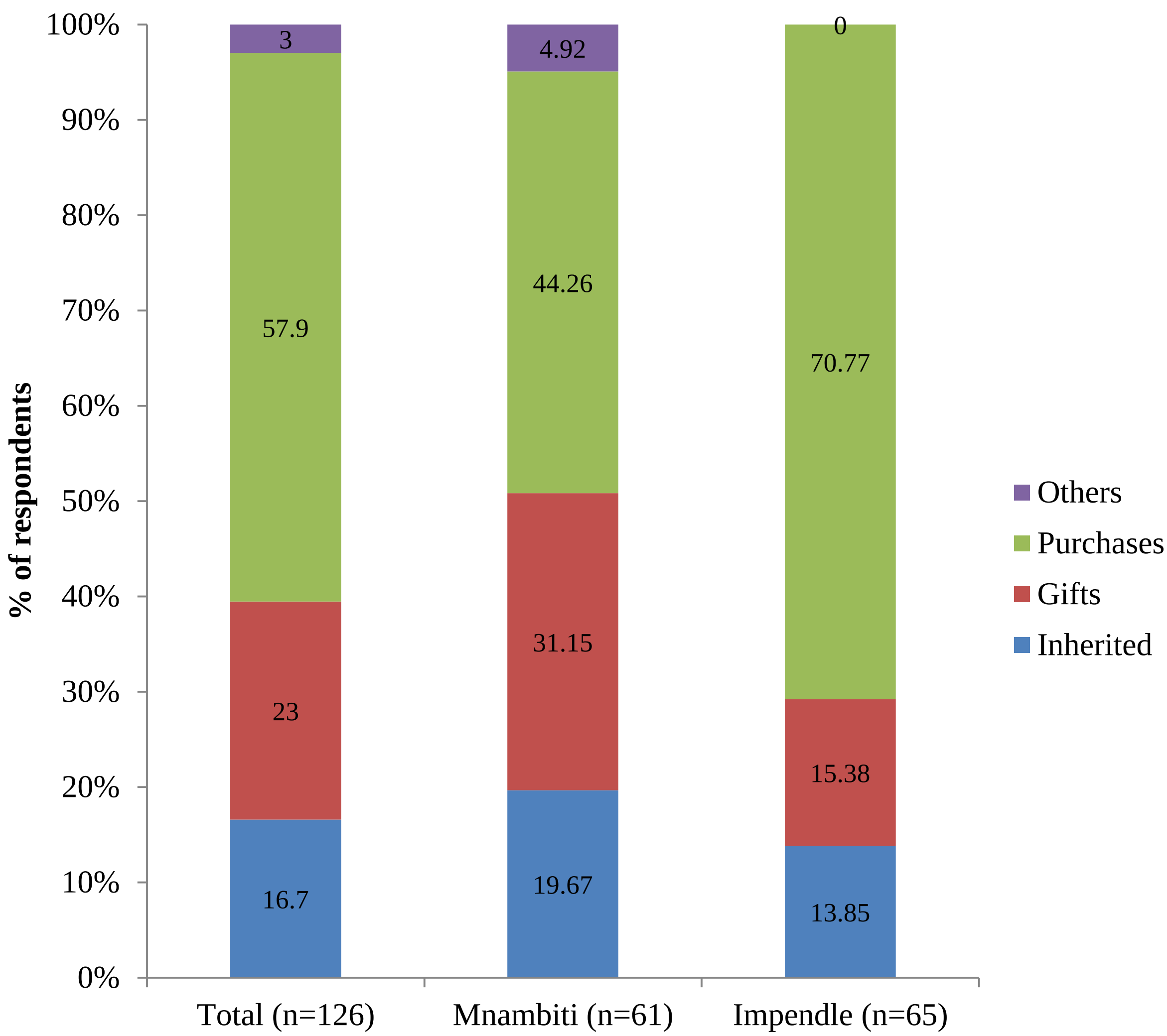

Figure 3.2 Sources of chickens for the farmers Mnambiti and Impendle

3.4.8 Feeding management

The management aspects were similar between the districts (P>0.05) and as such the results are combined for the two districts. However, where differences were noted the results are presented separately for each district. Although the scavenging system was the most dominant feeding system, the majority of the respondents provided supplementary feed, though of unknown quantities to their flocks. However, the type and the amount of feed depended on the crops grown in the previous season. In the cool dry season, the most dominant feeds given to the birds were unprocessed whole grain maize (43%), kitchen waste (35%) and crushed maize (18%). Only, one farmer who kept broilers used bought-in concentrates. In the hot wet season, which coincided with the growing season, kitchen waste was the dominant form of supplementary feed. In both seasons, maize supplementation was used as a tool to attract birds to a shelter at dusk or when the farmer wanted to take stock of his/her flock. About 10 % of the farmers supplied the supplementary feed in a container or feeder, while the remaining threw the feed on the ground thus making it accessible to all forms of livestock and leading to brutal encounters among birds and other livestock species for a bite. The competition for supplementary feed usually compelled the weaker individuals to venture into dangerous territory (predator rich) in search of food, thereby increasing the chances of being predated. Feeding of chickens was mostly done by women (55%) and children (23%) whilst men played a marginal role (18%).

3.4.9 Water provision

Over 80 %of the respondents provided water to their chickens, 16% providing throughout the day, 47% once per day, 15% once in two days, and 12% in more than two days. Only 6.6% of the farmers did not give water to their birds and admitted that their birds subsisted on water splashed after washing dishes or after bathing. On average, each bird received 0.367 and 0.439

litres of water per day in Mnambiti and Impendle, respectively, as estimated by the farmers. There was a significant association between district and the source of water (χ^2= 15.52; P < 0.05). Over 70 % of the respondents in both districts used tap water for their chickens. Farmers in Impendle had significantly more sources of water including boreholes (6.3%), wells (2.6%), municipality tankers (6.3%) and rivers (3.1%) compared to Mnambiti where tap water was the predominant source. The majority of farmers (93.8%) indicated that the water was of good quality, while the remainder indicated that the water provided to chickens was muddy, soapy or smelly. The type of container used for providing water to chickens varied between districts (χ^2= 30.62; P < 0.05). In Mnambiti, watering was mainly done in plastic containers (73.7 %) followed by used tyres (13.1%), metal containers (4.92%) and old clay pots (4.92%). The majority of the farmers in Impendle used metal cans (34.4%), old tyres (31.3%) with fewer using plastic containers (29.7%). The remaining 8 % did not have permanent drinking materials. However, the water troughs were accessible to all forms of livestock compromising on quality and quantity. Only 57.4% of the respondents in Mnambiti wash the containers daily, 30% wash the containers weekly and the remainder (12.6%) admitted that they never washed the containers. A significantly (χ^2= 6.54; P < 0.05) higher proportion of respondents (78.2%) in Impendle washed the containers daily compared to Mnambiti. Over 80% of the watering activity was performed by females and children.

The major problems encountered by farmers when providing water to their chicken flocks are shown in Figure 3.3. Although the respondents cited erratic water supply from the municipality water authorities, due to stringent water rationing and frequent breakdowns in the reticulation systems, focus group discussions revealed that inadequate water supply to chickens was also due to ignorance of the farmers. Most farmers professed ignorance on the need for regular water supply to the chickens.

3.4.10 Causes of chicken mortality in indigenous chicken flocks

Overall, 46% of the respondents indicated that diseases were the major cause of deaths in their chicken flocks in summer (Figure3.4). About 25.4, 22.4, 4 and 1.6% of the mortalities were ascribed to predators, feed shortages, water shortage and old age, respectively. The causes of death between districts were similar, with diseases being the major cause of mortality. In winter, diseases topped the list with 46.8% of the respondents highlighting it as a major cause of deaths in their flocks (Figure 3.5), followed by feed shortages (40%) and predators (27.8%). About 20 and 1.6% of the respondents attributed the deaths to shortage of water and old age, respectively. A significant association between district and causes of death among indigenous chicken flocks in winter was detected (χ^2= 12.378; $P < 0.05$). The number of deaths due to predation in winter was significantly higher in Mnambiti (41.0%) than in Impendle (15.4 %). Conversely, the number of respondents citing diseases and water shortages was higher in Impendle than in Mnambiti, 55.38 vs 37.7 and 23.08 vs 16.39, respectively. Across seasons, the most common diseases mentioned by the farmers include Newcastle disease (known as *Volomisa* in the local Zulu language), pneumonia caused by exposure to cold, wind and rain, and gastrointestinal and external parasites (worms, fleas and mites). Dogs, wild cats, snakes, hawks and thieves were given as the common predators of birds in the surveyed districts.

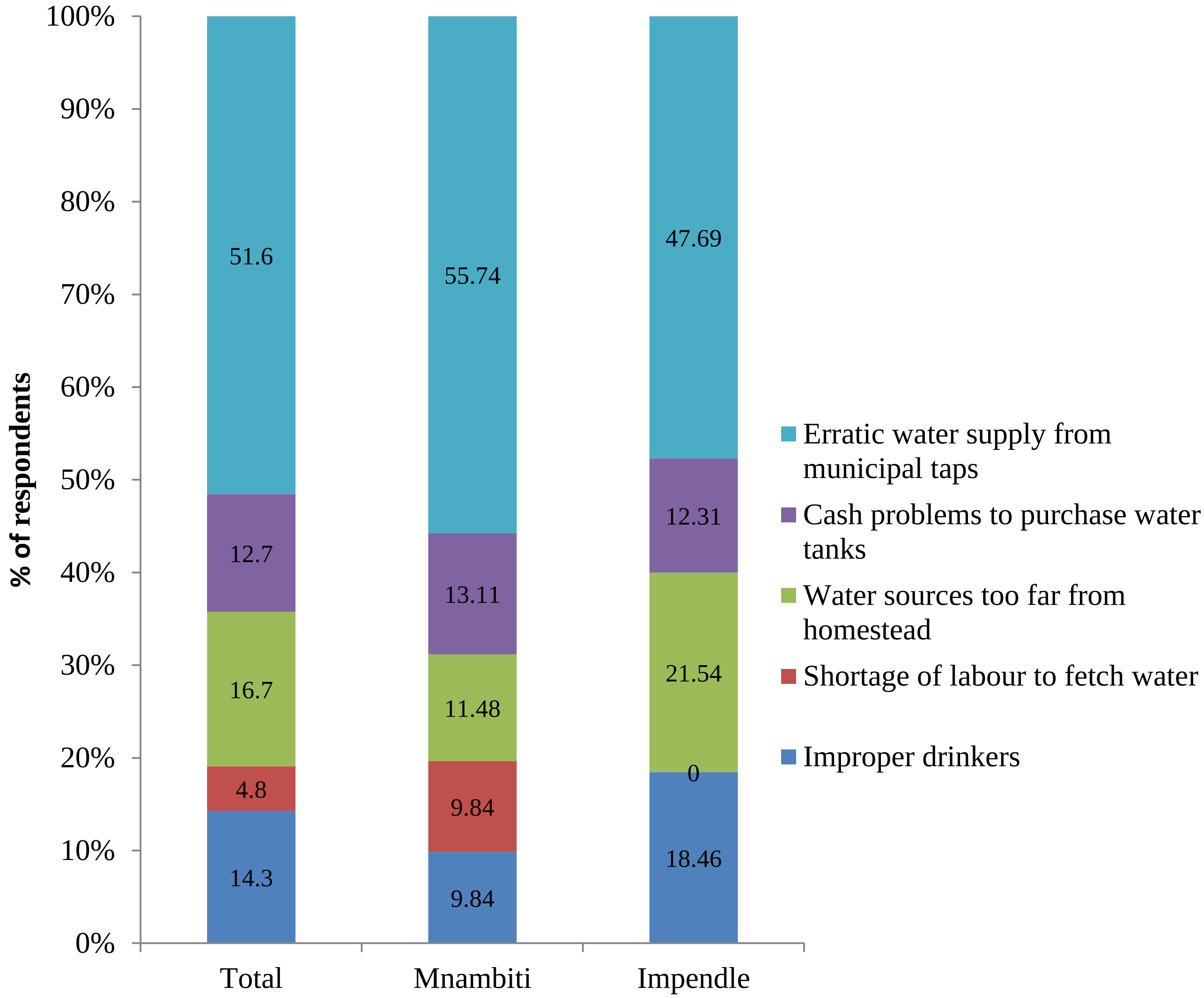

Figure 3.3: Problems encountered in providing water to chickens by communal farmers in Mnambiti and Impendle

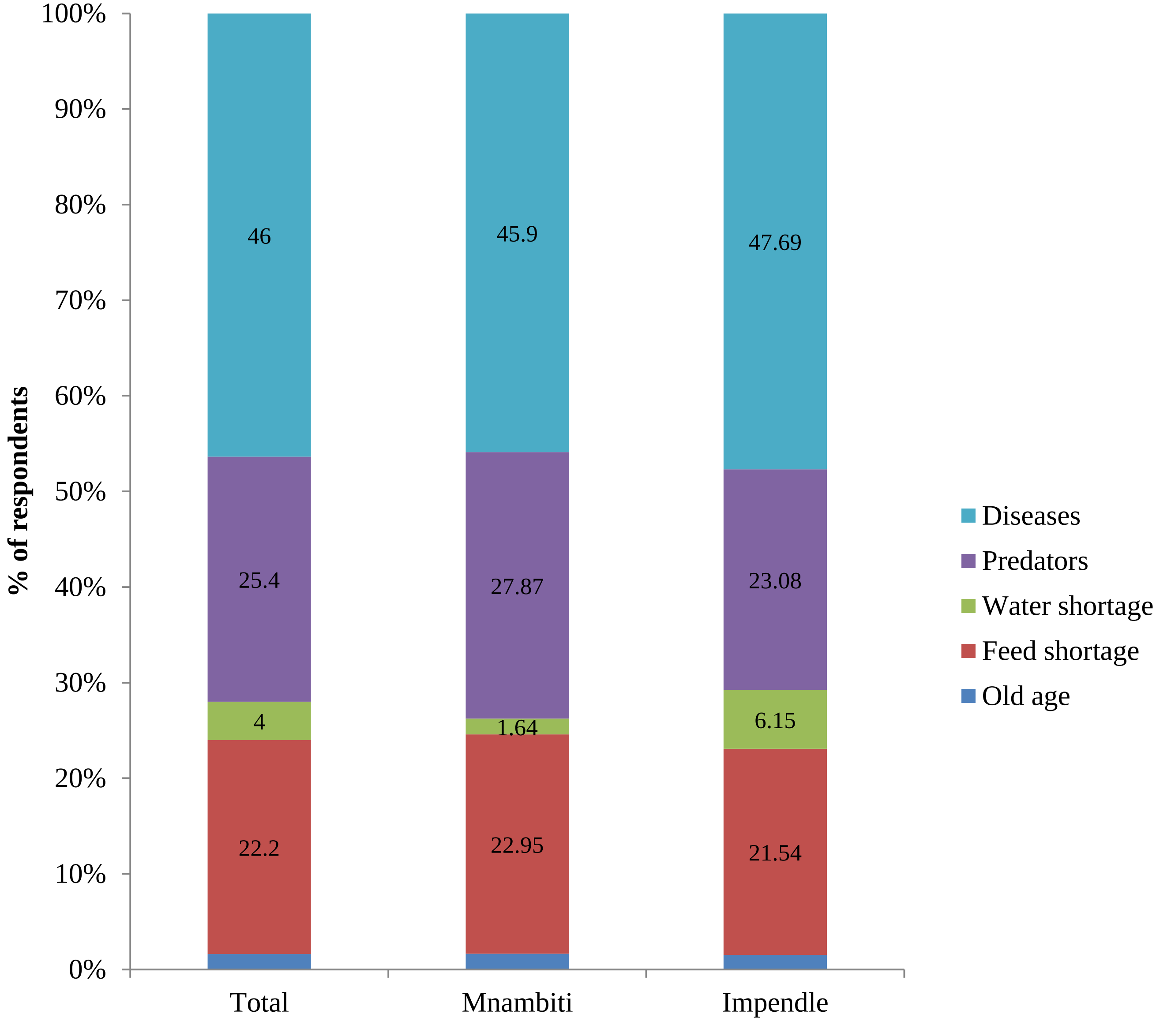

Figure 3.4: Causes of summer mortality in indigenous chickens in Mnambiti and Impendle

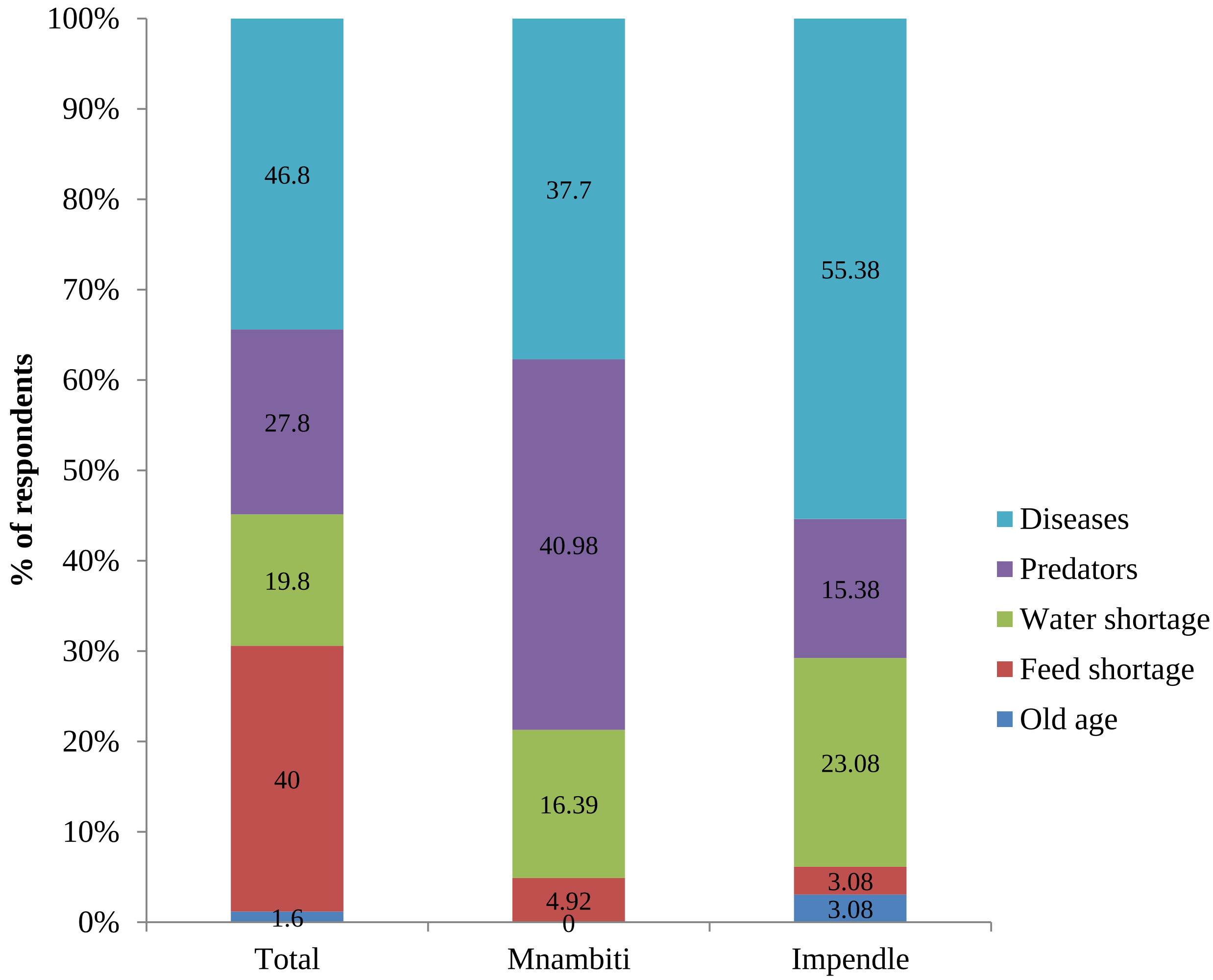

Figure 3.5. Causes of mortality in winter in indigenous chickens in Mnambiti and Impendle

3.5 Discussion

The observed mean household size of 6.6 persons/household concurs with findings of Swatson et al. (2001), who reported an average 6 persons per household in Vhembe district of the Limpopo province in South Africa. However, mean household size is both higher than the national average of 4.11 persons per household (Statistics, South Africa, 2010) and those reported for similar rural communities in Centane district of the Eastern Cape Province (Mwale et al., 2009). The age composition of households in the study areas also resembled the typical population pyramid of most developing countries. Contrary to observations made elsewhere in Africa, where most rural heads of households fell into the dependent age group aged above 66 years (Muchadeyi et al., 2004), the average age of household heads in the current study was 45, implying that most of them fell within the economically active group of adults aged between 16 and 65 years. The average farm size was small (1.3ha/household). Similar farm sizes were reported in North-west Ethiopia (Halima et al., 2007) and Zimbabwe (Muchadeyi et al., 2005). The average household owns two plots; the plot surrounding the homestead and the main plot usually away from the homestead. Land is not easily obtainable because of the high population density and, when sought, it is acquired through the headman or chief, since it's communally owned. The shortage of land profoundly influences the type of livestock kept in these areas as well as access to capital, agricultural markets or modern farm inputs required for sustainable agricultural production. Due to limited land the majority of farmers in the study areas own fewer ruminants than chickens.

The mean household flock sizes observed in Mnambiti and Impendle were comparable to the reported mean flock size of 17.5 chickens/household in the Mopane district of South Africa (Mtileni *et al.*, 2009). Similar flock sizes were reported by Swatson *et al*., 2001) in the Alfred district of Kwa-Zulu Natal in South Africa. In contrast, the mean flock size obtained in this study was higher than 9 and 5.6 chickens/ household reported for Tswana and Jamma chickens respectively (Aganga *et al.,* 2000; Mammo *et al.,* 2008). Generally, the flock size obtained in this study falls within the range of 5 to20 birds which, according to Sonaiya and Swan (2004), seems to be the limit that can be kept by a family without special inputs in terms of feeding, housing and labour. It was also evident that flock sizes vary widely (ranging from 2 to 60). This is a common observation in many rural areas of Africa (Kitalyi, 1998). Flock size variation in rural areas has been attributed to the farming systems practiced and local factors such as diseases and predators (Kuit *et al*., 1986).

The consistently higher proportion of chicks and hens in flocks observed in this study concurs with Tadelle and Ogle (1996) who reported that chicks account for the largest proportion of the indigenous chicken flocks in the central highlands of Ethiopia, followed by mature hens. The higher proportion of hens in the flocks indicates a strong desire for egg and chick production (Wilson *et al.,* 1987; Abdou *et al.,* 1992). It might also be a deliberate attempt by farmers to increase egg production and securing the sources of replacement or it could be attributed to lack of strong selection and culling against the hens and build-up of old and unproductive hens in the flocks (Meseret, 2010). The comparatively larger number of pullets per household compared to the proportions of cockerels and cocks in both districts could be a copping mechanism to replace the number of chicken reduced by selling, consumption and loss due to different reasons.

In any poultry set up, the proportion of hens in the flocks is an indication of egg and chick production (Mwalusanya, 2002). In the present study, the proportion of hens was larger, 63 and

73%, than the proportion of cocks, 37 and 23%, in Mnambiti and Impendle, respectively. Similar results were reported in coastal areas of Ghana (Awuni, 2006). In contrast to current findings, McAinsh et al. (2004) reported a cock to hen ratio of 1:6for indigenous chicken flocks in Sanyati, Zimbabwe. While the larger proportion of hens is believed to indicate that cockerels were preferred as slaughter birds whereas pullets were saved for reproduction purposes, the ratios from this study fell short of the recommended ratio for either the light and heavy poultry breeds (Austic *et al.*, 1990). This can be attributed to the lack of knowledge on indigenous chicken management and breeding by rural farmers and extension services. The survey results also suggest that the majority of the farmers own other livestock species such as cattle, sheep, goats and pigs. The coexistence of indigenous chicken production with other livestock enterprises on the farm increases diversity to the farming system and helps farmers to meet their multiple obligations and reduces vulnerability during periods when food is in short supply and the demand for cash is high (Francis et al., 2001).

The main role of chickens was the provision of meat as reported in several articles (Dlamini 2002; Mapiye et al. 2008; Mwale et al., 2009). This could be attributed to the fact that it is easier to slaughter a bird for consumption than cattle, and considering its size, it would not present difficulties of storing meat. In keeping with rural famers' objective of enhancing household food security, it is rational for farmers to reserve their chickens for family consumption rather than for sale (Mapiye et al. 2008). Our results showed that farmers also considered cash from chickens very important in meeting their daily household requirements, in agreement with Naidoo (2000) and Guèye (2001) who affirmed that village chickens contribute to cash of the resource-poor rural communities. The result that farmers used manure in their gardens and crop fields confirms past reports highlighting integration of poultry with other enterprises Gandiya (1995). The low ranking for observed for use of chickens as a form of wealth investment was expected since, unlike cattle, chickens are not kept as a sign of wealth (Musemwa et al. 2008). In contrast with previous studies by Naidoo (2000) in North-eastern KwaZulu-Natal province and Swatson et al. (2001) in KwaZulu-Natal where chickens are mainly used in rituals, farmers in Mnambiti and Impendle do not use chickens for rituals. Instead, cattle were the ones essentially used for ceremonies.

Chickens were owned mainly by women, as is the common practice in other African countries (Halima et al., 2007). Chickens are generally considered livestock species of women and children whether in male-headed or female-headed households. Other studies have concluded gender plurality in ownership, management and decision-making of resources (Kitalyi, 1998; Mwale et al., 2009). When the ownership pattern was related to decision-making especially in the sales of chicken, men generally took most of the decisions. While targeting women in chicken production contributes to improved household nutrition and income, it is important to ensure that men are involved so that they support the women. The low proportion of youth and children who own chickens was discouraging in view of their role as future custodians of indigenous chicken genetic resources.

The observation that the majority of farmers provided dietary supplements for their chicken flocks agrees with earlier reports in South Africa (Dlamini 2002: Mtileni et al., 2009), Zimbabwe (McAinsh *et al.*, 2004; Muchadeyi *et al.*, 2005) and Ethiopia (Halima et al., 2007).The birds were predominantly supplemented with maize grain, which alone does not meet all the nutritional requirements of birds due to its relatively low crude protein content. However, this is not regarded as a major constraint as the birds get some protein from scavenging on insects, termites, earthworms, termites and leguminous grains (Muchadeyi et al 2004; Mwale et al., 2009). Use of maize grain to supplement scavenging chickens was also reported in South Africa (Mtileni et al., 2009; Rwanedzi, 2010), Zimbabwe (Mapiye et al., 2008; Mlambo et al., 2011) and in other countries in Africa (Kitalyi, 1998; Roberts, 1992; Dessie and Ogle, 2001; Kondombo*et al*., 2003). Household left-over food was not regarded as feed supplement but as part of the scavenging feed resource base that is provided to chickens as waste thrown into refuse heaps, from which chickens could scratch and eat. Grain supplementation was more common during the cool-dry season. Dessie and Ogle (2001), Pedersen (2002) and Kondombo*et al. (*2003) reported similar seasonal influence on supplementing feed to chickens in Ethiopia, Zimbabwe and Burkina Faso, respectively. In South Africa, as in other developing countries in Africa, most rural households experience seasonal food deficits during the hot-dry season (September to November) when food reserves from harvested crops run out (Swatson *et al.*, 2003: Mwale*et al*., 2009; Rwanedzi, 2010). Subsequently there are fewer by-products available, resulting in farmers reducing dietary supplementation.

Despite variations in the sources of water and frequency of watering, almost all of the respondents provided water for their chickens. However, the water troughs were accessible to all forms of livestock compromising on quality and quantity.Detailed studies to monitor the microbial quality of the water are required to reduce the spread of water borne diseases and hence mortality.

The observation that women were responsible for most of the activities like provision of water and supplementary feed to chicken is consistent with the findings of Bradley (1992), who argued that management of village chicken is highly associated with women for various historical and social factors. Mapiye*et al.* (2005) reported that women, in Rushinga district of Zimbabwe, dominated in most of the activities on village chicken production like; feeding (37.7%), watering (51.2%) and cleaning of bird's house (37.2%), whereas men were dominant in shelter constructions (60%) and treatment of chickens (40%). Results of this study reaffirm the assertion that village chicken production is the domain of women and, therefore, calls for a purposeful targeting of the women when introducing technologies in free-range management as this is likely to be the appropriate entry point to poverty alleviation in the rural communities.

The high incidence of chicken mortality due to diseases, particularly Newcastle disease, is similar to findings by Mtileni *et al.* (2009) who reported high prevalence of the disease in the Vhembe and Mopane Districts in the Limpopo Province, Kgalagadi District in the Northern Cape Province, and the Alfred-Nzo District in the Eastern Cape Province of South Africa. Similar results were reported by Swatson *et al.* (2001) in the KwaZulu Natal Province of South Africa and by Moreki *et al.* (2003), Kusina *et al.* (2001) and Gondwe *et al.* (2007), in the SADC region. Disease control in the survey districts is constrained by the poor animal health service delivery by either Government or private animal health service providers. Contrary to reports elsewhere in South Africa, use of traditional medicine in Mnambiti and Impendle was used sparingly, in contrast to regular use reported by Mtileni *et al.* (2009) and Mwale *et al.* (2009), farmers in the Eastern Cape. Maphosa *et al.* (2004) also reported that a high percentage of farmers do not offer health interventions to sick birds. Lack of health response by the farmers was largely attributed to lack of cash to purchase veterinary medicine and shortage of veterinary and extension services. Reports of high predation by hawks, eagles and wild cats, especially in Mnambiti where some households did not provide shelter for the chickens is in agreement with previous studies (Dlamini, 2002). The reported high rate of predation can be reduced by close monitoring of the chickens during the day, when they range freely, and providing appropriate night shelter (Mapiye et al., 2008). Hunting, trapping or poisoning of predators can also reduce loss of birds due to predators.

3.6 Conclusions

In both Mnambiti and Impendle, indigenous chicken production plays a key socio-economic role and contributes to food security. Constraints to chicken production are numerous. Farmers need to diversify the range of supplements offered to chickens by providing a composite diet that includes maize and other protein-rich feeds grown in the area, in particular the harvesting and production of novel sources of protein such as insects, termites and earth worms. With regard to increasing survival of indigenous chickens, it is imperative that farmers explore traditional remedies for treatment of some ailments, and local veterinary officers should enforce strict adherence to vaccination programmes against decimating diseases. This should be complemented by comprehensive training programmes on indigenous chicken husbandry. Losses due to predation implore farmers to provide overnight housing for older birds and construction of brooders using locally available materials for their chicks. Most of the indigenous chicken production is managed by women; focusing training and education of women will not only improve outputs from chickens but also the living standards of households and the community at large. However it is necessary to identify and characterize appropriate chicken breeds under the prevailing extensive or semi-intensive rearing conditions and their possible inputs for the development of commercially viable free ranging indigenous chicken market

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Chapter 4: Comparison of morphometric characteristics and weights of internal organs of Potchefstroom Koekoek, Black Australorp, Venda and Ovambo chickens

Abstract

It is important to identify and characterize appropriate chicken breeds under the prevailing extensive or semi-intensive rearing conditions and their possible inputs for the development of commercially viable free ranging indigenous chicken 'niche' market. The objective of the study was to compare morphometric characteristics of Black Australorp, Potchefstroom Koekoek, Venda and Ovambo chickens. A flock of 200 indigenous chickens, 50 each of Potchefstroom Koekoek, Black Australorp, Ovambo and Venda breeds were reared under semi-intensive system for 22 weeks. The chickens were slaughtered at 22 weeks of age by manual neck cut, bled for 2 min, de-feathered. The offals were removed and the dressed weight was recorded. Body weights and linear body measurements (Head length, head width, comb height, comb length, beak length, body length, neck length, breast girth, shank length, drumstick length, drumstick circumference, keel length and wing length) of the birds were measured using a flexible tape prior to slaughter. The weights of lungs, heart, kidney and spleen were recorded after slaughter. The body weight for the Black Australorp were higher ($P<0.05$) than the other breeds. There was no significant difference between the lung, heart kidney and spleen weights among breeds. Linear regression analysis showed that the body length, shank length and wing length were significant ($P<0.05$) in predicting body weight. The shank length was selected by stepwise regression as the most powerful measurement in predicting bodyweight, with a partial R-square of 0.64. In the rural areas where scale is not available, any of these body parameters could be used to predict the body weight of indigenous chickens.

Key words: Morphometric traits, Black Australorp, Venda, Ovambo and Potchefstroom Koekoek

4.1 Introduction

The quantification of morphometric variations has been regarded as peripheral to the mechanistic study of development of a species. This is vital for understanding various parameters in chickens (Islam and Dutta, 2010). Chickens in rural areas have not been subjected to extensive selection; have low introgression and hence less genetic dilution. They are managed under extensive/free range systems with occasional feed supplementation. Because of their nature of production (organic farming), local chicken currently have widespread market acceptability as more affluent consumers prefer such birds to those produced under intensive systems. These chicken genotypes have proven very useful and require being maintained (Ozoje *et al.*, 1999).

As stated in the previous chapter the most dominant feeds given to the birds were unprocessed whole grain maize (43%), Kitchen waste (35%) and crushed maize (18%).Most village chickens can survive cold and heat, wet and drought conditions. Some subsistence farmers keep these chickens for household consumption (meat and eggs) only. Apart from these products, farmers use indigenous chickens to supplement household income. Farmers indicated the multiple functions of indigenous chickens but the majority ranked meat consumption as the most important (Table 3.4). Meat consumption was followed by cash income.

It is difficult to characterize existing phenotypes as random mating is the main breeding system used. A body weight of 2.25 kg was reported by Swatson *et al*. (2003) for non-descript breeds reared under traditional unimproved farming systems in the Northern Limpopo Province of South Africa. Adaptability of indigenous chickens in the tropical environment has been through small body sizes (Olawunmi *et al.*, 2008). Small body sizes reduce feed requirements for maintenance and also increase feed conversion efficiency. This is necessary for survival in the free range system because of scarce feed resources and the uncertainty surrounding feed supply. Identifying breeds that are superior in adaptability and meat production could therefore be crucial.

Little is known about differences in linear type traits and organ weights among the Australorp, Potchefstroom Koekoek, Venda and Ovambo used in poultry improvement programme in South Africa. It is necessary to identify and characterize appropriate chicken breeds under the prevailing extensive or semi-intensive rearing conditions and their possible contribution to the development of indigenous chicken production. This will also enable poultry development workers, extensionists, researchers and even policy makers, to provide relevant information to farmers.

Morphometric measurements are useful in contrasting size and shape of animals (McCracken *et al*., 2000). It is important that chicken farmers monitor the growth performance of birds regularly to know when they have attained the desired market weight. Also to determine whether the animals are responding to any feeding programme and to what extent birds lose body weight in times of high parasite and disease challenges. In places where scales are not available, as is the case in most rural communities, linear body measurements can be used to predict body weight in chickens. The objectives of the current study were to:

1. compare morphometric characteristics in Black Australorp, Potchefstroom Koekoek, Venda and Ovambo chickens; and
2. Predict body weight of these birds using linear body measurements.

The hypotheses tested were that:

1. Differences exist in morphometric characteristics of the Black Australorp, Potchefstroom Koekoek, Venda and Ovambo chickens; and
2. There is relationships exist between linear morphometric measurements and body weight to chickens.

4.2 Materials and methods

4.2.1 Study site

Research ethics were approved by the Humanities and Social Sciences Research Ethics Committee. The study was conducted between January and March 2011 at Cedara College of Agriculture (30° 15’ 29” E; 29°33’ 04”S), in KwaZulu-Natal Province, South Africa. It lies at altitude 613m.The minimum, maximum and average temperature and relative humidity during the experimental weeks are summarized in Table 4.1. The average environmental temperature was 22.3°C, which is considered to be within the average seasonal temperature for the Kwazulu-Natal Midlands. Relative humidity was moderate at an average of 65.8 % (Table 4.1).

Table 4.1: Average minimum and maximum temperature and average relative humidity from week 1 to 7 of the trial

Month	Temperature °C			Relative humidity %
	Mean	Minimum	Maximum	
0	22.4	16.4	28.3	76.6
1	23.5	18.0	29.0	71.8
2	22.9	18.6	27.1	75.6
3	24.4	19.3	29.4	61.3
4	25.4	18.1	32.6	61.8
5	21.8	16.1	27.4	60.5
6	20.5	14.3	26.7	63.0
7	17.9	12.1	23.7	56.3

4.2.2 Birds and their management

A flock of 200 unsexed freely ranging indigenous chickens of Potchefstroom Koekoek, Black Australorp, Ovambo and Venda breeds were reared under an improved semi-intensive system for 22 weeks. 50 each of Potchefstroom Koekoek, Black Australorp, Ovambo and Venda breeds were reared under semi-intensive system for 22 weeks. Chickens were raised as one group in an open-sided house with a cement floor, deep littered with wood shavings. During the brooding period (Day 1 to 4 weeks of age) a proprietary starter diet (220g CP/kg DM) was fed as a mash. Thereafter, the chickens were allowed unrestricted access to a combination of a grower diet (180g CP/kgDM), yellow maize and access to a kikuyu pasture. The supplementary grower diet (180g CP/kgDM) was provided *ad libitum* in tube feeders made of standard gutter, 30cm long × 12cm wide × 9cm deep. The chemical compositions of the diets are shown in Table 4.2. Water was also provided *ad libitum* using 10l plastic founts.

At 22 weeks of age, 31, 17, 14 and 8 cocks of Potchefstroom Koekoek, Black Australorp, Ovambo and Venda were randomly selected for the determination of morphometric characteristics. Cocks were used in this study because in chapter 3 most farmers preferred slaughtering them as opposed to hens. Since indigenous chickens are slow growers and they normally reach the maturity weight at around 22 weeks.

Table 4.2: Chemical composition of starter and grower diets

Component (g/kg)	Starter	Grower
Protein	180.0	200.0
Moisture	120.0	120.0
Fat	25.0	25.0
Fibre	50.0	60.0
Calcium	8.0	7.0
Calcium	12.0	12.0
Phosphorus	6.0	5.5
Total lysine	12.0	10.0

4.2.3 Morphometric trait measurements

Body weights of the birds were measured using a kitchen weighing balance with a capacity to weigh up to 3 kg. Before slaughter, body length, chest circumference, shank length, head length, head width, comb height, comb length, beak length, neck length, drumstick length, drumstick circumference, wing length and keel length were measured. All lengths were measured using a flexible tape graduated on a centimeter scale.

Body length (BLT) was considered to be the distance between the last cervical vertebrae before the thoracic vertebrae and the caudal vertebrae, i.e. the length of the synsacrum which is fused with the pelvic girdle. Breast girth (BRG) was taken as the circumference of the breast around the deepest region of the breast. Shank length was taken as of the tarso-metatarsus from the hock joint to the metatarsal pad. Head length was measured as the distance between the occipital bone to the insertion of the beak into the skull. Head width was measured at the eyes level. Comb height was measured as the distance from the tip of the central spike until insertion of the comb in the skull. Comb length was measured as the distance between the insertion of the comb in the beak and the end of the comb's lobe. Beak length was measured as the length from the tip of the beak until insertion of the beak into the skull. Neck length was measured as the distance between the nape and the insertion of the neck into the body. Drumstick length was measured as the length from shinbone femur joint, to shinbone tarsus joint. Drumstick circumference is the circumference around the deepest region of the drumstick Wing length is measured as the distance between the ends of the longest primaries with wings stretched. Keel length is measured as the distance between both vertices of the sternum when leaning the bird on its back.

4.2.4 Weight measurements

After the measurement of linear traits, the chickens were slaughtered by manual neck cut, bled for 2 min, put in a container with boiling, de-feathered and re-weighed. After recording weight, each bird was eviscerated and the organs separated. Then the dressed carcass, breast, thigh, drumstick, back, neck, drummettes, wing, scapular, liver weight, lung, heart, kidney, and gastrointestinal (GIT) weights were taken and calculated as a percentage of body weight. Weights of internal organs were also taken with the aid of electric scale. The length of the (GIT) was measured using tape. The gizzard was separated from the GIT and weighed separately. The gizzard was cut open and the contents were removed before weighing.

4.2.5 Statistical analysis

The statistical analyses system (SAS, 2008) was used to analyze the data. The model used was:

$Y_{ij} = \mu + B_i + E_{ij}$, where:

Y_{ij} is the response in the dependent variable

μ is the mean common to all observations

B_i is the effect of breed and

E_{ij} is the random residual error.

Statistical significance was considered at the 5% level of probability.

Pairwise comparisons were done using the pdiff statement in SAS

Linear regression was used to estimate liver, lung, heart, kidney, gizzard weights from dressed weight.

Linear regression was used to estimate body weight from the linear measurements (wing length, shank length and body length.

4.4 Results

4.4.1 Morphometric traits

Table 4.3 shows that, at 22 weeks of age, the Black Australorp and the Venda were heavier ($P< 0.05$) than the Potchefstroom Koekoek and Ovambo cocks. The Potchefstroom Koekoek had the ($P< 0.05$) longest head compared with the rest of the breeds. There was no significant difference between the Black Australorp, Ovambo and Venda breeds were similar with respect to comb length. The Black Australorp was superior to the other breeds with respect to body length, breast girth, and shank length compared to the other breeds ($P < 0.05$). The Black Australorp and the Venda had the highest body lengths ($P< 0.05$). Of all four breeds, the Potchefstroom Koekoek had the shortest ($P> 0.05$) neck. The Black Australorp had the highest ($P< 0.05$) breast girth, followed by the Ovambo. The Black Australorp had the longest shanks ($P< 0.05$). The Potchefstroom Koekoek ($P< 0.05$) had the shortest drumstick. There was no significant difference ($P > 0.05$) in head width, comb height, beak length, drumstick circumference, keel length and wing length among the breeds.

4.4.2 Weights of edible body parts in the Black Australorp, Ovambo, Potchefstroom Koekoek and Venda cocks

The Black Australorp had the heaviest ($P< 0.05$) weights for the edible parts (drumstick, thigh, breast and wing) (Table 4.4) the Ovambo was the lightest of breeds. There was no significant difference between the back, neck and the scapular weights among all breeds

Table 4.3: Least square means (± standard errors) of morphometric traits among theBlack Australorp, Ovambo, Potchefstroom Koekoek and Venda cocks

Parameter	Black Australorp	Ovambo	Potchefstroom Koekoek	Venda	(P-Value)
Body weight (kg)	3.0 ± 0.08^{a}	2.4 ± 0.09^{b}	2.5 ± 0.08^{b}	2.7 ± 0.10^{ab}	**
Head length (mm)	55.1 ± 2.18^{a}	50.8 ± 2.30^{b}	62.6 ± 2.18^{a}	53.0 ± 2.61^{b}	*
Head width (mm)	38.8 ± 1.07	35.1 ± 1.13	34.8 ± 1.07	36.8 ± 1.29	ns
Comb height (mm)	46.3 ± 2.09	38.2 ± 2.20	38.9 ± 2.09	40.5 ± 2.49	ns
Comb length (mm)	91.4 ± 3.36^{a}	83.3 ± 3.54^{ab}	74.1 ± 3.36^{b}	81.0 ± 4.00^{ab}	*
Beak length (mm)	20.0 ± 0.78	17.5 ± 0.82	17.2 ± 0.78	19.4 ± 0.92	ns
Body length (cm)	26.2 ± 0.55^{a}	24.5 ± 0.58^{ab}	23.2 ± 0.55^{b}	25.7 ± 0.66^{a}	*
Neck length (cm)	16.6 ± 0.70^{a}	17.9 ± 0.73^{a}	13.1 ± 0.70^{b}	16.8 ± 0.83^{a}	**
Breast girth (cm)	39.3 ± 0.83^{a}	34.1 ± 0.88^{b}	33.2 ± 0.83^{b}	35.7 ± 0.99^{b}	**
Shank length (cm)	13.8 ± 0.42^{a}	8.75 ± 0.44^{b}	8.7 ± 0.42^{b}	9.3 ± 0.50^{b}	**
Drumstick length (cm)	14.2 ± 0.44^{a}	13.7 ± 0.46^{a}	12.3 ± 0.44^{b}	13.6 ± 0.52^{a}	*
Drumstick cir (cm)	14.5 ± 0.50	14.1 ± 0.53	14.5 ± 0.50	15.0 ± 0.60	ns
Keel length (cm)	14.6 ± 0.58	14.4 ± 0.61	13.2 ± 0.58	13.4 ± 0.69	ns
Wing length (cm)	15.2 ± 0.31	14.5 ± 0.33	15.0 ± 0.31	15.1 ± 0.37	ns

Values in the same row with different superscript are significantly different (P< 0.05).

Values in the same row with the same superscript are not significantly different (P> 0.05).

ns= not significant * P<0.05 **P<0.001

Table 4.4: Weights of edible body parts in the Black Australorp, Ovambo, Potchefstroom Koekoek and Venda cocks

	Breed				
Parameter	Black Australorp	Ovambo	Potchefstroom Koekoek	Venda	Significance
Dressed weight (g)	1950.0 ± 79.43[a]	1644.0 ± 79.43[b]	1685.8 ± 75.36[b]	1697.0 ± 90.07[b]	*
Breast (g)	500.7 ± 21.89[a]	389.7 ± 21.89[b]	395.5 ± 20.76[b]	428.5 ± 24.82[ab]	*
Thigh (g)	368.2 ± 13.21[a]	293.0 ± 13.21[b]	315.2 ± 12.54[b]	315.1 ± 14.98[ab]	*
Drumstick (g)	343.4 ± 13.48[a]	268.8 ± 13.48[b]	289.1 ± 12.79b	279.8 ± 15.29[b]	*
Back (g)	325.2 ± 20.31	324.7 ± 20.31	288.1 ± 19.27	310.9 ± 23.03	ns
Neck (g)	158.42 ± 9.33	127.3 ±9.33	151.9± 8.85	143.9 ± 10.58	ns
Drummettes (g)	120.75 ± 4.19[a]	96.35 ± 4.19[b]	100.2 ± 3.97[b]	98.8 ± 4.75[b]	**
Wing (g)	118.8 ± 3.90[a]	94.5 ± 3.90[b]	97.3 ± 3.70[b]	101.6 ± 4.42[b]	**
Scapular (g)	45.7 ± 3.84	42.8 ±3.84	43.4 ± 3.64	43.48 ± 4.35	ns

Values in the same row with different superscript are significantly different (P< 0.05).

Values in the same row with the same superscript are not significantly different (P> 0.05).

ns= not significant * P<0.05 **P<0.001

4.4.3 Weights of offals and organs

As shown in Table 4.5, there was no significant difference in caeca weight ($P > 0.05$). The weight of the GIT for the Black Australorp and Venda were not significantly different ($P > 0.05$). The leg and head weights were heavier for the Black Australorp ($P > 0.05$). The Ovambo had lower liver weight than the other three breeds ($P < 0.05$; Table 4.5). There was no significant difference between the lung, heart, kidney and spleen.

4.4.4 Estimation of the liver, lung, heart, kidney and gizzard weight from dressed weight

The internal organ weights were predicted using dressed weight. Linear regression analysis showed that the liver, lung and heart had a linear relationship with dressed weight ($P<0.01$). The kidney and gizzard weight were also significantly affected by the dressed weight ($P< 0.05$). The heart weight was selected by stepwise regression as the most powerful organ in which dressed weight can be used predict internal organ weight, with a partial R-square of 0.58, as shown in Table 4.6.

Table 4.5: Least square means (± standard errors) of weights of offals

	Breed				
Organ	Black Australorp	Ovambo	Potchefstroom Koekoek	Venda	Significance
Caecum (g)	7.1 ± 0.23	6.8 ±0.23	6.7 ± 0.22	7.0 ± 0.26	ns
GIT(g)	75.0 ± 4.77[a]	52.9±4.71[b]	59.0 ± 4.46[b]	73.0 ± 5.34[a]	*
Leg (g)	102.4 ± 3.44[a]	82.7±3.44[b]	86.1 ± 3.26[b]	81.3 ± 3.90[b]	**
Head (g)	107.1 ± 4.60[a]	89.1±4.60[b]	89.4 ± 4.36[b]	83.3 ± 5.21[b]	**
Liver (g)	55.7 ± 2.98[a]	42.2 ± 2.98[b]	45.2± 2.82[ab]	53.4±3.38[a]	*
Lung (g)	17.0 ± 1.13	14.24 ±1.13	13.3 ± 1.08	16.2± 1.29	ns
Heart (g)	20.1 ± 0.89	16.9 ±0.89	18.0 ± 0.85	18.0 ± 1.01	ns
Kidney (g)	13.9 ± 1.06	10.8 ±1.06	12.3 ± 1.01	13.8 ± 1.20	ns
Gizzard (g)	56.0 ± 2.85[a]	47.5 ± 2.85[ab]	51.5 ± 2.71[ab]	64.4 ± 3.23[a]	*
Spleen (g)	4.2 ± 0.33	3.3 ± 0.33	3.7 ± 0.32	4.14 ± 0.37	ns

Values in the same row with different superscript are significantly different (P< 0.05).

Values in the same row with the same superscript are not significantly different (P> 0.05).

ns= not significant * P<0.05 **P<0.001

Table 4.6: Estimates (± SE) for dressed weight to predict weights of the liver, lung, heart, kidney and gizzard in indigenous chickens

	Liver	Lung	Heart	Kidney	Gizzard
Intercept	10.75±10.13	-1.70±3.08	3.58±2.16	3.29±3.55	30.07±11.29
Linear regression coefficient	0.02±0.005	0.01±0.002	0.008±0.001	0.005±0.002	0.01±0.006
R^2	0.30	0.47	0.58	0.17	0.12

4.4.6 Estimation of body weight from linear measurements

Linear regression analysis showed that the body length, shank length and wing length were significant ($P<0.05$) in predicting body weight. In Table 4.7, the body measurements were used to predict body weight. The shank length was selected by stepwise regression as the most powerful measurement in predicting bodyweight, with a partial R-square of 0.64, as shown in Table 4.7 followed by the wing and body length with a partial R-square of 0.52 and 0.33, respectively.

4.5 Discussion

The main reason for studying morphometric traits was to estimate the adaptability, growth and development of indigenous birds, to determine the meat yield, to predict the body and internal organ weights of these birds. Thus, by using a measuring tape, it could be possible to predict the body weight of these birds with high level of accuracy, body, shank and wing length being body measurements that are most suitable for this purpose. The measuring tape is much more available than weighing scales in most communal production systems of South Africa. In this way, farmers can identify appropriate breeds that are suitable for their peculiar production system.

The results suggest that the Ovambo and Potchefstroom show remarkable adaptations to survive in rural areas. Semakula *et al*. (2011) argued that the small stature of chickens shows their adaptability in the tropics. A small body size is results in reduced maintenance, feed requirements and an increase in feed conversion efficiency, particularly in the tropics. This is necessary for survival in the free range system because of scarce feed resources and the uncertainty surrounding feed supply Yakubu *et al*., (2009). Abdul-Rahman (1989) reported that body weight and body size play a vital role in adaptability. Gowe and Fairfull (1995) reported

Table 4.7: Estimates (±SE) for estimating body weight using linear body measurements

	Intercept	Bodyweight	R^2
Body length	0.2 ± 0.59	0.1 ± 0.02	0.33
Wing length	-1.6 ± 0.73	0.1 ± 0.04	0.52
Shank length	-1.6 ± 0.64	0.1 ± 0.02	0.64

that small birds showed a smaller change in body temperature when exposed to acute heat than larger body weight birds. It is possible that the Venda, Ovambo and Potchefstroom Koekoek breeds used were able to adjust well under thermal straps because of their small body weight and size.

The observed body weights for the experimental birds were higher than the average of 2.3 kg reported by Swatson *et al*., (2003) for non-descript breeds reared under traditional unimproved farming systems. The reason for the bigger body weights observed in the current study could be due to improved management like feed, water and housing. Under improved free ranging poultry rearing conditions, the Black Australorp exhibited desirable growth performance characteristics by maximizing the use of the supplementary feeds on offer and access to pasture. The Black Australorp and the Venda had the highest body lengths. Body length is related to body weight, and is usually associated with egg laying (Olawunmi *et al*., 2008), this requires further investigation.

The Black Australorp and Ovambo had the highest breast girth Yakubu *et al*., (2009) suggested that this trait is closely correlated to high meat yield. The Black Australorp had the longest shank length, which is a trait widely considered in estimating the growth and development (Leeson and Caston, 1993), and thus had more rapid growth and development. The Potchefstroom Koekoek had the shortest drumstick length this is associated with the height of the bird (Leeson and Caston, 1993). The Black Australorp had the highest weight measurements for the edible parts. The superiority of the Black Australorp over the other breed for most body measurements, especially breast yield, suggests that the breed had high levels of muscling and meatiness (Olawunmi, 2008).

The leg and head weights were more superior for the Black Australorp than for the other three breeds. The weights of the liver and gizzard were higher in Black Australorp than the other breeds; probably because of its higher body weight. The size of gizzard is determined by the amount of work required by the muscular walls of the organs to grind feeds particles (Musa *et al.,* 2006; Obun *et al*., 2008). The well-developed muscular gizzard of the Black Australorp enable it to grind and efficiently utilise the feed on offer. Thus feed utilisation and consequently growth rates of such birds are expected to be higher than for other breeds. Comb height, drumstick circumference and lengths of the beaks, body, shanks, keels and wings were similar among all breeds. These findings are comparable to those reported by Fayeye *et al*. (2006) on Nigerian indigenous chickens; they find that Comb height, drumstick circumference and lengths of the beaks, body, shanks, keels and wings were similar among all breeds. The observed body weights of the Venda, Ovambo, and Potchefstroom Koekoek agree with Oluyemi and Roberts (2000), that indigenous chickens have relatively small body weights, on their study on indigenous chickens in Nigeria.

Under traditional farming systems, where the scavengeable feed resource base and poultry management is adequate, the Black Australorp breed and/or its crosses with indigenous breeds could be recommended and promoted. Where an unplanned multiple mating system exists, with birds scavenging for their feed requirements and receive small amounts of supplementary feeds, the Ovambo or Venda chickens could be more appropriate to keep. These breeds are expected to perform better when the scavengeable feed resource base is limiting and environmental conditions are harsh. The comparatively low body weight of Ovambo and Venda breeds make it easy for them to roost in trees or in places high above the ground and also to avoid predators as it is shown in figure 3.4 and 3.5 that it is one of the major causes of chicken mortality. In comparison to the Australorp, they are also an important reservoir of genetic variation that must not be lost from smallholder communal production systems. The socio-cultural conditions within the communal area may also determine which breed to recommend. Unique preferences may exist for feather color patterns that may be preferable but have not been considered in the current study. There is, however, a known preference by rural communities in KwaZulu-Natal, for example, for the black or red feathered chickens as these are also used for traditional ceremonies like weddings and ancestral worship. Thus, it is difficult to recommend any particular breed without fully understanding the status quo of the conditions under which they may be kept and the purposes for which they are to be used.

Linear body measurements were used to predict body weight of chickens. The shank length accounted for 64 % of the variation in body weight. This suggests that the body parameters are good predictors for body weight in indigenous chickens. Therefore, in communal production systems, where weighing scales are scarce or not available, any of these linear body measurements could be used to predict the body weight of chickens. Akanno *et al*. (2007) also made similar observations when he used linear body measurements such as shank length, drum stick length and wing length to predict body weight in broilers. Body length accounted for 33 % and was highly significant, Semakula *et al.*, (2011) also studied the use of body parts in determining body weight and concluded that chest girth and body length can be used to predict body weight. In mature indigenous chickens in Senegal, Guèye *et al*. (1998) also found that body length and chest girth were strongly and significantly correlated to body weight. But chest girth was not selected by stepwise regression in results in the current study.

4.6 Conclusions

Differences existed in morphometric characteristics of the Black Australorp in comparison to the Potchefstroom Koekoek, Venda and Ovambo chickens. The Potchefstroom Koekoek, Venda and Ovambo have small bodies which make them highly adaptable. The Australorp had the highest body weight and as well as the weights of edible parts. The Under the improved rearing conditions, the Black Australorp was able to optimize the use of feed resources on offer to both maximize its growth performance of commercially desirable body parts for the "niche" free ranging indigenous chicken market. There exist a possibility of improving smallholder poultry production by making use of breeds such as the Black Australorp, Venda and Ovambo. A single prediction equation could be used to estimate body weights of the Black Australorp, Potchefstroom Koekoek, Venda and Ovambo chickens. This suggests that the body parameters are very good predictors for body weight in chickens. Therefore, in the rural areas where scale is not available, any of these body parameters could be used to predict the body weight of indigenous chickens. However, it is crucial to evaluate consumer acceptability of indigenous chicken meat as to determine if there is really market for this type of meat.

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Chapter 5: Consumer acceptability of meat from Potchefstroom Koekoek, Black Australorp, Venda and Ovambo chickens

Abstract

Consumer perceptions are important in the immediate and future decision of a purchase. The objective of the current study was to compare consumer acceptability of meat from chickens that are indigenous to South Africa compared to imported Black Australorp and the broiler. The effects of breed on the sensory attributes were determined using the GLM procedure of SAS (2008). A flock of 200 unsexed freely ranging indigenous chickens of Potchefstroom Koekoek, Black Australorp, Ovambo and Venda breeds were reared under an improved semi-intensive system for 22 weeks at Cedara College of Agriculture in KwaZulu-Natal Province, South Africa. Cooked meat samples from each breed were presented in a random order to 69 consumer panelists drawn from the University of KwaZulu-Natal, Cedara College of Agriculture and the Department of Agriculture. Age of consumer had no effect on all the meat quality attributes ($P>0.05$). Breed had a significant effect on taste and overall acceptability ($P< 0.05$), but there was no significant difference on meat colour, texture and aroma. Gender of consumer had a significant effect ($P<0.01$) on taste, colour and texture, but no significant effect on aroma and overall acceptability. Female respondents gave lower scores for taste ($P<0.01$).There was no interaction between gender and breed on meat texture. Crossbreeding the indigenous chickens with improved breeds such as the Black Australorp is one avenue through which sensory characteristics of the indigenous chickens may be improved.

Key words: Consumer acceptability, Black Australorp, Venda, Ovambo and Potchefstroom Koekoek

5.1 Introduction

Worldwide consumption of poultry meat is growing in developing countries. Poultry products are universally popular, because they are not subject to cultural or religious restrictions and poultry meat itself is perceived as healthy and nutritious as it contains relatively low fat content and more desirable unsaturated fatty acids than other meats (Jaturasitha *et. al*, 2008). Poultry is sold primarily as poultry slaughter in the state as a dead carcass of the product, but in poorer regions is often sold in the form of live poultry in quantities up to 30% of total production (Haščík *et al.*, 2011). The two most important quality attributes for poultry meat are appearance and texture. Appearance is critical for both the consumers' initial selection of the product as well as for final product satisfaction (Fletcher, 2002). Texture is the single most important sensory property affecting final quality assessment.

The 21st century has witnessed an increase in consumer preference for organic meat, presumably due to their perceived superior meat flavour, meat texture and health benefits because of lesser use of chemicals compared to intensively raised commercial strains (Castellini *et al*., 2008). Consumer interest in organic and free-range poultry production is growing (Neufeld, 2002). It is necessary that communal farmers strive to increase production of indigenous chickens to exploit the economic gains presented by the growing demand for natural and organic meat (Neufeld, 2002). The major challenge with rural chicken production is their small flock sizes, low growth rates and poor marketing systems and channels. Inadequate nutrition is also a challenge to chicken productivity (Muchadeyi *et al*., 2004). Indigenous chickens are well adapted to harsh environmental conditions but they, however, have slow growth rate, and low feed conversion efficiency.

Although numerous studies have compared the productive performance and quality of eggs from indigenous chickens (Van Marle-Köster and Webb, 2000; Van Marle-Köster and Casey, 2001; Grobellar et al., 2010), very few studies, if any, have compared the consumer acceptability of the meat from indigenous chicken genotypes. Instead, the majority of the reports fail to recognize the inherent differences among indigenous genotypes and broadly refer to indigenous chickens as a single population. The hypothesis tested was that there are no differences in sensory attributes among the Black Australorp, Broiler, Venda, Ovambo and the Potchefstroom Koekoek. It is highly likely that different breeds have different sensory properties to their products. Information on meat from indigenous South African genotypes is unfortunately not known. There is no information on the acceptability of indigenous chickens to consumers. The objective of the study was to compare sensory characteristics of chicken indigenous to South Africa compared to imported Black Australorp and the broiler, and to assess the consumer acceptability of meat from indigenous breeds of chicken.

5.2 Materials and methods

5.2.1 Description of study site

Research ethics were approved by the Humanities and Social Sciences Research Ethics Committee. The study was conducted at Cedara College of Agriculture (30° 15' 29" E; 29°33' 04"S), in KwaZulu-Natal Province, South Africa.

5.2.2 Birds and their management

The birds and their management are described in section 4.2.2. Five broilers were purchased from market in the city of Pietermaritzburg. They were about eight weeks old.

5.2.1 Cooking method

Breast meat was used for consumer acceptability. Meat samples for each breed were prepared separately by roasting in an oven. Every consumer tasted a portion of 30g of each of the breeds. The oven temperatures were set at 140°C. At this temperature, there is little shrinkage; the meat cooks better, is juicy and has more flavour. A table spoon of salt (20g) was added for taste. The meat was placed in the oven for 45 minutes. A meat thermometer was used to determine the internal temperature of the meat. The meat was considered well done when the internal temperature was 85°C.

5.2.2 Sensory evaluation

Cooked meat samples from each treatment were presented in a random order and coded with three figure random numbers, to avoid bias and the "order effect". 69 consumer panellists drawn from the University of KwaZulu-Natal, Cedara College of Agriculture and the Department of Agriculture were used. All the participants were trained on how to infer and record scores for each variable tasted. The waiting period between meat sample tasting was 10 minutes. After tasting, the panellists were instructed to rinse their mouths with water before tasting the next sample to avoid crossover effects. White boards were used to separate consumers to avoid copying. Each participant completed an evaluation form, rating the characteristics of each sample.

A 9-point hedonic scale was used to evaluate taste, colour, texture, aroma and overall acceptability. This describes the panellists' perception of the product, i.e. overall like or dislike of the product. The rating scale was such that: 1= dislike extremely 2=dislike very much 3=dislike moderately 4=dislike slightly 5=neither like or dislike 6=like slightly 7=like moderately 8=like very much 9=like extremely (Appendices 2 and 3). After tasting the panellists were instructed to rinse their mouths with water before tasting the next sample to avoid cross effects. The waiting period before tasting the next sample was 10 minutes. Improvised cubicles fabricated from white board paper were used to separate consumers to prevent them influencing each other in the evaluation of the meat samples.

5.3 Statistical analysis

Data were tested for normality. The effects breed of chicken and the gender of panelist on the sensory attributes was determined using the GLM procedure of SAS (2002). The linear model was $Y_{ijk} = \mu + G_i + B_{ij} + E_{ijk,}$ where

Y_{ijk} is the response variable,

μ is the mean common to all observations,

G_i is the effect of panellist gender,

B_{ij} is the effect of breed, and

E_{ijk} is the random error.

Least square means and standard error for each body meat quality attributes were computed using SAS (2008).

5.4 Results

5.4.1 Effects of age and gender of consumer panelists and breed and gender on sensory attributes

Table 5.1 shows that breed of chicken had a significant effect on taste and overall acceptability ($P < 0.05$), but there was no significant difference in colour texture and aroma acceptability.

Panelist gender had a significant effect (P<0.01) on taste, colour and texture acceptability but had no significant effect (P>0.05) on aroma and overall acceptability. Panelist gender of and chicken breed had no effect on taste, texture, aroma and overall acceptability (P>0.05) but had a significant effect on color (P< 0.05).

Table 5.1: Effects of age and gender of consumer panelists and breed and gender on sensory attributes

Parameter	Chicken breed	Panellist gender	Panellist gender x Chicken breed
Taste	*	**	ns
Colour	ns	**	*
Texture	ns	**	ns
Aroma	ns	ns	ns
Overall acceptability	*	ns	ns

ns= not significant * P<0.05 **P<0.01***P<0.001

5.4.2 Effects of breed of chicken and gender of respondents on meat taste, colour and texture

Table 5.2 shows that the Ovambo and the Potchefstroom Koekoek had the lowest taste scores (P<0.05). Female panellists also gave lower scores for taste (P<0.01). There was no interaction between panellist gender and chicken breed on taste scores of the meat. Table 5.2 shows that chicken breed had no significant effect on colour acceptability of the meat ($P>0.05$). However, panellist gender had a significant effect on colour acceptability of the meat ($P<0.05$). There was an interaction between panellist gender and chicken breed; with the broiler receiving the highest scores from the female panellist. Table 5.3 also shows that the texture acceptability of meat was strongly affected by gender ($P<0.01$). Female panellists gave lower scores than males. There was no interaction between panellist gender and chicken breed on texture acceptability of the meat.

5.4.3 Effects of breed and gender of consumers on aroma and overall acceptability

Table 5.3 shows that aroma acceptability was not significantly affected by chicken breed and panellist gender and there was no interaction between panellist gender and chicken breed to affect aroma acceptability. Table 5.3 shows that overall acceptability of the chicken meat was significantly affected by breed ($P<0.05$) and panellist gender, male panellist gave the highest scores for overall acceptability for the Black Australorp and there was no interaction between panellist gender and chicken breed to affect the overall acceptability of the meat.

Table 5.2: Effects of breed of chicken and gender of respondents on taste, colour and texture

Breed	Gender of respondent	Taste	Color	Texture
Black Australorp	Female	5.7 ± 0.41^{b}	6.1 ± 0.37^{b}	5.9 ± 0.39^{b}
	Male	6.1 ± 0.30^{b}	6.3 ± 0.27^{b}	6.3 ± 0.29^{c}
Venda	Female	5.9 ± 0.42^{b}	5.6 ± 0.38^{a}	5.5 ± 0.40^{ab}
	Male	6.1 ± 0.29^{b}	5.9 ± 0.27^{ab}	5.7 ± 0.28^{b}
Ovambo	Female	4.5 ± 0.41^{a}	5.1 ± 0.37^{a}	5.3 ± 0.39^{a}
	Male	5.7 ± 0.30^{b}	5.8 ± 0.28^{a}	6.1 ± 0.29^{c}
Potchefstroom	Female	5.1 ± 0.42^{a}	5.0 ± 0.38^{a}	4.5 ± 0.40^{a}
Koekoek	Male	5.9 ± 0.29^{b}	6.4 ± 0.27^{b}	$5.9 \pm 0.28b^{c}$
Broiler	Female	5.6 ± 0.41^{ab}	6.5 ± 0.37^{b}	5.6 ± 0.39^{b}
	Male	6.3 ± 0.30^{b}	5.9 ± 0.27^{b}	6.0 ± 0.29^{c}

Values in the same row with different superscript are significantly different ($P< 0.05$).

Table 5.3: Effects of breed of chicken and gender of consumers on aroma and overall acceptability

Breed	Gender	Aroma	Overall acceptability
Black Australorp	Female	6.4 ± 0.39	6.3 ± 0.34^{ab}
	Male	5.8 ± 0.29	6.5 ± 0.25^{c}
Venda	Female	5.3 ± 0.40	6.0 ± 0.35a^{b}
	Male	5.7 ± 0.28	5.8 ± 0.24^{ab}
Ovambo	Female	5.0 ± 0.39	5.3 ± 0.34^{a}
	Male	5.7 ± 0.28	5.9 ± 0.24^{ab}
Potchefstroom Koekoek	Female	5.2 ± 0.40	5.4 ± 0.35^{a}
	Male	5.6 ± 0.28	6.2 ± 0.24^{b}
Broiler	Female	5.7 ± 0.40	6.1 ± 0.34^{ab}
	Male	5.8 ± 0.29	6.2 ± 0.25^{b}

Values in the same row with different superscript are significantly different (P< 0.05).

5.5 Discussion

Poultry meat is an alternative meat for health conscious consumers, as it contains low cholesterol and fat. However, consumers prefer indigenous chicken meat because it is more chewy and tasty. There is a growing market for organic meat as oppose to broilers. There are few reports on consumer acceptability of meat from indigenous chickens in South Africa. Knowledge on such factors in resource-poor poultry production systems is low. Although trained panels are preferred to assess sensory characteristics of meat, it has been demonstrated that consumers can describe products in a reliable manner. There is, however, no information on their acceptability and palatability and sensory characteristics to consumers. One of the major factors that affect the eating quality of meat is the nutritional status of the animal with breed and diet having an impact on flavour (Warren *et al*., 2008). Only consumers can provide reliable and appropriate information about the acceptability of the meat (Simela *et al*., 2008).

Preference for local chicken meat was based on the perceived taste, toughness and freedom from chemical contaminants. Most of the consumers can be suspicious about the safety of broiler chicken meat. Generally, consumers perceive local chicken to be the tastiest and safest of all other chicken meats on the market (Castellini *et al.*, 2008). Consumers' preference for local chicken indicates a potential niche for the indigenous chickens in the South African meat market.

All the sensory attributes were not affected by the age of panelist. This is similar to findings by Dyubele *et al*., (2010) who stated that age of the consumer did not have an effect on most sensory characteristics. It was expected that the younger generation would score higher scores for the broiler since they are used to eating broiler portions available in supermarkets. Taste and overall acceptability were significantly affected by the breed of chicken, with the Black Australorp and Venda receiving the highest scores for taste, the Black Australorp and the broiler receiving the highest scores for overall acceptability. Dyubele *et al*. (2010) also reported significant breed effects on most sensory attributes, with broiler meat having the highest scores. This, therefore, shows that different breeds have different sensory characteristics despite being reared under the same conditions. Thus, genetic factors influence the sensory properties of chicken meat. The findings of this study shows that male consumers awarded higher scores for all the sensory attributes for the Black Australorp and Potchefstroom Koekoek chicken meat is contrary to earlier findings (Simela *et al*., 2008; Xazela *et al.*, 2011) who stated that females tend to give higher scores in sensory evaluation, when they studied chevon.

Texture is, arguably, the most important attribute in consumers' final satisfaction with poultry meat (Fletcher, 2002). The results of this study on the texture acceptability of the different breeds of the chicken indicate that either gender's liking of the texture of the meat was not influenced by chicken breed. However, male consumers liked the texture of chicken meat more than female consumers. The fact that males recorded the highest scores for most sensory attributes, including texture, compared to females could be due to the fact that meat is more regarded masculine than feminine (Fiddes, 1991). The texture of the meat might have been tough, which would be suited to men as they would more enjoy applying appreciable force when eating the meat than females. Aroma intensity was similar for all breeds, which agrees with Xazela *et al*. (2011**).** The results suggest that all the chicken breeds had a similar profile of aromatic (volatile) substances, which would include the volatile fatty acids.

Generally, consumers expect meat from indigenous chickens to be tastier than meat from broilers. This agrees with Jahan *et al*. (2005) and Jaturasitha *et al*. (2008) that indigenous chicken meat has unique characteristics such as low fat, fatty acid composition might also play a role making it more ideal for the health status of communal farmers but this is in contrast with findings by Dyubele *et al*. (2010). Overall acceptability of meat of indigenous chicken was better than those of improved varieties. The Black Australorp and the broiler received the highest and similar scores for sensory attributes, while the Venda, Ovambo and the Potchefstroom Koekoek received lower and similar scores.

5.6 Conclusions

Mainly indigenous chicken farmers would find these results useful for managing the indigenous chicken supply chain. Indigenous strains have the potential as a product for a niche market. To produce meat with specific qualitative characteristics, the importance of indigenous chicken breeds need to be better understood. Information generated from this study could give indications that breeds like the Venda and Ovambo should be used for the different production objectives and consumer preferences, with the goal of up-scaling the production of meat from extensive production systems based on specific indigenous genotypes. Crossbreeding the indigenous chickens with improved breeds such as the Black Australorp is one avenue through which sensory characteristics of the indigenous chickens may be improved. Indigenous chicken farmers could practice the use of commercial feed as this seems to have an effect on growth performance and body weight of these chickens. The chickens in the current study were slaughtered at 6 months while farmers in rural areas slaughter at one year and above.

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Chapter 6: General Discussion, Conclusion and Recommendations

6.1 General Discussion

The objectives of the study were to characterize the village chicken production systems, compare morphometric characteristics and assess consumer acceptability of meat from indigenous breeds of chicken. Characterization of indigenous chickens was determined in Chapter 3; morphometric characteristics were determined in Chapter 4 and consumer acceptability of the meat was determined in Chapter 5.

In Chapter 3, it is shown the main role of chickens was to provide a source of meat for communal farmers in South Africa as has been reported by (Dlamini 2002; Mapiye *et al*., 2008; Mwale *et al*., 2009). Farmers also considered cash from chickens very important in meeting their daily household requirements, in agreement with Naidoo (2000) and Guèye (2001) who affirmed that village chickens contribute to cash of the resource-poor rural communities. Indigenous chicken production in the study areas plays a key socio-economic role and contributes to protein malnutrition alleviation. However, there still exist serious constraints to its development in terms of nutrition and health management. With regard to increasing survival of indigenous chickens, it is imperative that farmers explore traditional remedies for treatment of some ailments, and local veterinary officers should enforce strict adherence to vaccination programmes against decimating diseases such as Newcastle disease. This should be complemented by comprehensive training programs on all aspects of indigenous chicken husbandry for villagers. Losses due to predation implore farmers to provide overnight housing for older birds and construction of brooders using locally available materials for their chicks. As most of the indigenous chicken production is managed by women, focusing training and education of women will not only improve outputs from chickens but also the living standards of households and the community at large**.** However it is necessary to identify and characterize appropriate chicken breeds under the prevailing extensive or semi-intensive rearing conditions and their possible inputs for the development of commercially viable free ranging indigenous chicken market

In Chapter 4,the smaller body size of the Ovambo and Potchefstroom suggests that they are adaptable, small body sizes is said to be important to reduce maintenance feed requirements and increase feed efficiency in the tropics (Olawunmi *et al*., 2008).This is necessary for survival in the free range system because of scarce feed resources and the uncertainty surrounding feed supply (Yakubu *et al*., 2009).The Black Australorp and the Venda had the highest body lengths; body length is related to body weight this is normally associated with egg laying (Olawunmi *et al.*, 2008). The Black Australorp had the highest breast girth, suggesting that it produces the most meat yield, followed by the Ovambo. This is similar to findings by (Yakubu *et al.*, 2009 who studied Nigerian indigenous chickens. Body measurements were also used to predict body weight of chickens. Shank length accounted for 64% of the variation in body weight followed by the body and wing length which accounted for 33 and 52% respectively. This suggests that the body parameters are very good predictors for body weight in indigenous chickens (Akanno et al., 2007). Therefore, in the rural areas where scales are not available, any of these body parameters could be used to predict the body weight of chickens. However, it is crucial to evaluate consumer acceptability of indigenous chicken meat as to determine if there is really market for this type of meat.

In Chapter 5, the hypothesis tested was that there are no differences in sensory attributes among the Black Australorp, Broiler, Venda, Ovambo and the Potchefstroom Koekoek. It was found that the taste and overall acceptability were significant affected by the breed with the Black Australorp and Venda receiving the highest scores for taste, the Black Australorp and the broiler receiving the highest scores for overall acceptability. Consumers expect that meat from village chickens is tastier than meat from broilers. This agrees with Jaturasitha *et al.* (2008) that indigenous chicken meat has unique characteristics and probably that is why it is more acceptable taste than improved breeds.

Crossbreeding the indigenous chickens with improved breeds such as the Black Australorp is one avenue through which sensory characteristics of the indigenous chickens may be improved. Long-term exposure to conventional broiler meat flavour may cause resistance in the perception of other flavours. Consumer perception, whether ‘real’ or ‘conditioned’, is important in the immediate and future decision of a purchase. Texture and tenderness in particular, are crucial consumer attributes. Organic chicken meat is generally firmer and more strongly flavoured than broiler meat (Jahan *et al.*, 2005).

6.2 Conclusions

It is shown from the work that indigenous chickens play a vital role in livelihoods of communal famers. Morphometric traits are positively related to body weight and can be used to predict body weight. Consumers preferred indigenous chicken meat over the imported breeds. These factors should therefore be taken into consideration for development of future chicken breeding and marketing strategies in South Africa

6.3 Recommendations

Indigenous chicken production as a means to alleviate poverty could be increased if the constraints are properly targeted. Farmers need to diversify the range of supplements offered to chickens by providing a composite diet that includes maize and other protein-rich feeds grown in the area, in particular the harvesting and production of novel sources of protein such as insects, termites and earth worms. Under the improved rearing conditions the black Australorp breed was able to optimize the use of feed resources on offer to both maximize its growth performance of commercially desirable body parts for the "niche" freely ranging poultry market and the development of its gastro-intestinal tract especially the gizzard. There exist a possibility of improving small holder poultry production by making use of breeds such as the Black Australorp, Venda and Ovambo. However, an optimum combination of feeds on offer and rearing conditions should be provided. As the differences were minor in magnitude, indigenous strains have the potential to as a product for a niche market. The importance of indigenous chicken breeds need to be better understood, in order to make it possible to produce meat with specific qualitative characteristics.

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Appendix 1

Survey questionnaire on indigenous chicken production by smallholder farmers in KwaZulu Natal

Enumerator Name: ………………………… Date of interview:……………………………………...
District Name:………………………….. Ward Name: ……………………………………....
Village Name: …………………………. Agro-Ecological Zone: ……………………………....
Farm type: 1. Communal 2. Small Scale Commercial
GPS Reading:……………………………………………………………….
Interviewee:………………………………………

1. **Household characteristics**
   a. Sex of household Head: (1). Male ☐ (2). Female ☐
   b. Age of Household head: (1) <30 ☐ (2) 31-40 ☐ (3) 41-50 ☐ (4) 51-60 ☐ (5) 61-70 ☐ (6) > 70 ☐ (7)Unknown ☐
   c. Any agricultural training received? (1) Yes ☐ (2) No ☐
   d. Is the head resident on the farm? (1)Yes ☐ (2) No ☐

2. **Number of people residing permanently in household**
   1. Adult males: ……………………...
   2. Adult females:………………..…..
   3. Children <15 years:………………

3. **Land holding/ farm size?**

	Area (hectares)
Crops	
Forest	
Grazing/communal	
TOTAL	

4. **Numbers and livestock species kept**

Species	Numbers	Rank	Ownership
Chicken			
Sheep			
Goats			
Cattle			
Pigs			
Others (specify)……………….			

B. CHICKEN PRODUCTION SYSTEM

5. Numbers and age class of birds kept, and production system used

Age class of birds	Number	Production system
Chicks		
Pullets		
Cockerels		
Hens		
Cocks		
Broilers		
Layers		

6. Why do you keep chickens?

Purpose	**Please tick**	**Rank (1= most important)**
Meat		
Eggs		
Manure		
Cash from sales		
Investment		
Ceremonies		
Cultural		

7. Who owns the Chickens?

Owner	**Please tick**	**Number of birds**
Head		
Spouse		
Sons		
Daughters		
Others (Specify)		

8. **How did you acquire your chickens? 1.**Inherited☐ 2. Gifts ☐ 3.Bought ☐
4.Others (specify)…………………………………………………………………

9. **What role(s) does each family member play in chicken production?**

	Adults		Boys	Girls	Hired labour
	Males	Females			
a. Purchasing					
b. Selling of birds					
c..Breeding decisions					
d. Feeding and Watering					
e. Bird health					

10. How do you feed your chickens?

Season	Supplementary feed	Scavenging feed	Both

Summer/Wet			
Winter/ Dry			

11. What type of feed is given to birds during;

Season	Type of feed				
	Kitchen waste	Bought concentrate	Home made ration	Crushed grain	Whole grain
Summer/Wet					
Winter/Dry					

WATERING SYSTEMS

12. How do your chickens access water?

Season	**Scavenge for water**	**Water is provided**	**Both**
Summer/Wet			
Winter/Dry			

13. What are the sources of water for birds? (Tick one or more)

Tap water	Waste water (Kitchen, laundry)	Borehole	Water well	Municipality tankers	River	Dam/pond	Do not know

14. What is the distance to the farthest water point?

(1). At household (2). < I km (3) 1 to 5 km (4) 6 to 10 km (5) > 10 km

15.What is the quality of water that your chickens drink? (Tick one or more)

(1)Good (2) Muddy (3) Salty (4) Smelly (5) Don't know

16. Who is responsible for providing water to chickens?

(1)Household head (2) Wife (3) Boys (4) Girls (5) Hired labour

17. What is the frequency of water supply to chickens?

(1) Freely available (2) once a day (3) Twice a day (4) Every other day (5)Once in 2 days

(6)More than 2 days (7) Others (specify)…………………………..

18. Where is the water normally put?

(1)In the chicken house (2) Under a granery (3) dug out pond (4) In the yard

19. How is the water provided to chickens?

(1) Placed in drinkers (2) used old tyre (3) plastic container (4) metal container (5) dug out pond

20. How often do you clean the containers?

(1)Daily (2) weekly (3) monthly

21. How much water do you give to your chickens?

	Quantity in litres
Chicks	
Pullets	
Cockerels	
Hens	
Cocks	

22. Which class of birds is most affected by high ambient temperatures and water stress?
1. Chicks☐ 2. Pullets☐ 3.Cockerels☐ 4. Hens☐ 5.Cocks ☐

23. What signs do they show when water stressed?

	Move away from other birds	**Move against cooler surfaces**	**Lift their wings to expose skin**	**Panting**	**Reduced feeding**	**Drink more water**
Chicks						
Pullets						
Cockerels						
Hens						
Cocks						

24. Which strain of bird is least affected by high temperatures and water stress?
(Enumerator to describe strain)

25. In times of water scarcity which species do you give priority? (Tick in order of rank)
Cattle ☐ Sheep ☐ Goats ☐ Chickens ☐ Pigs ☐ Others ☐

26. In times of water scarcity, which class of birds do you give priority?
1. Chicks☐ 2. Pullets☐ 3.Cockerels☐ 4. Hens☐ 5.Cocks ☐

27. What are the major causes of mortality of your chicken during the dry season?
1. Old age ☐ 2. Poor diet ☐ 3. Water shortage ☐ 4. Predators ☐
5. Diseases ☐

28. What are the major causes of mortality of your chicken during the wet season?
1. Old age ☐ 2. Poor diet ☐ 3. Water shortage ☐ 4. Predators ☐
5. Diseases ☐

29. What problems do you encounter in providing water to chickens?

Problems	**Suggested solution**
Lack of proper drinkers	

Shortage of labour to fetch water	
Water sources too far away from homestead	
Lack of money to buy storage tanks	
Erratic water supplies due to frequent cut offs by municipality	
Frequent breakdowns of water pumps/ boreholes	

28. Which class of chickens do you normally slaughter for consumption?

Class of chicken	**Tick**
1. Chicks	
2. Pullets	
3. Cockerels	
4. Layer	
5. Cock	

b. Reasons:

1……………………………………………………………………………………………………..

2.

……………………………………………………………………………………………………….

3.

……………………………………………………………………………………………………..

4………………………………………………

Appendix 2

Sensory evaluation of chicken
Gender______________ DOB:______________ Panelist Number:______________

Samples code	**Sensory Characteristics**					**Comments**
	Taste	**Colour**	**Texture**	**Aroma**	**Overall**	

Thank you!

Sensory evaluation of meat from indigenous chicken.

Instructions:

1. Please rinse your mouth with water before starting. You are also required to rinse your mouth with water after testing each food sample.

2. Please do not smoke 30 minutes before or during the evaluation.

3. Please do not consume any food products 15 minutes before the evaluation.

4. Please do not communicate with other panellists during or after the evaluation.

5. Please rate the taste, texture, aroma, colour and overall acceptability of the samples according to the scale given below. These samples must be evaluated in the order that they are provided (from left to right). You may re-evaluate the sample if necessary.

9 ______ **Like extremely**

8 ______ **Like very much**

7 ______ **Like moderately**

6 ______ **Like slightly**

5 ______ **Neither like nor dislike**

4 ______ **Dislike slightly**

3 ______ **Dislike moderately**

2 ______ **Dislike very much**

1 ______ **Dislike extremely**

Appendix 3

Invitation to sensory evaluation participants

Dear Potential Panellist,

Sensory evaluation of chicken

You are invited to participate in a sensory evaluation panel to evaluate the above-named food. These sessions will last for ~15 minutes per session. Participants must attend one session. Participation in this sensory evaluation panel is entirely voluntary and you may choose to withdraw from this study at any time.

For further information you can contact me on 211557881@ukzn.ac.za or call me on 0733963933 or my co-supervisor, Dr. M. Siwela, can be contacted at siwelam@ukzn.ac.za or on his work number (033) 2605459.

Sincerely: Mandisa Mngonyama (Msc. Agric student)

Appendix 4

Consent Form

I Mandisa Mngonyama, a student at the University of KwaZulu-Natal doing MSc in Animal Science. I am conducting a study (as the requirement for the course) on evaluation of meat quality from indigenous breeds of chickens used in communal production systems. All data collected from this study will be confidential and will only be used as part of this research project. Rate each meat sample provided using the 9-point hedonic scale and indicate these scores on the evaluation sheet. This information will be used to determine the consumer acceptability of meat from the different chicken breeds.

I, …………………………................... (name) hereby confirm that the questionnaire has been clearly explained to me and I understand the purpose of this study and how this information is going to be tested.

I therefore agree to voluntarily participate in this research study.

……………………. ……………………………

Signature Date